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FEASIBILITY STUDY REPORT
for SOILS and SUBSURFACE GAS

WASTE DISPOSAL, INC. SUPERFUND SITE

Santa Fe Springs, California

Prepared by

**U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IX**

AUGUST 2, 1993

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1.0 SITE CHARACTERIZATION

1.1 Introduction

The purpose of this Feasibility Study (FS) is to identify, screen, and evaluate remedial action alternatives for contaminated soils and subsurface gas at the Waste Disposal, Inc. (WDI) facility in Santa Fe Springs, California. The FS is based on data collected during the Remedial Investigation (RI), and will lead to a Proposed Plan and Record of Decision (ROD) to address contaminated soils and subsurface gas at the site. Contaminated groundwater will be addressed separately in a subsequent document.

The contents of this section will detail the conditions, history, regulatory involvement, environmental considerations and contamination present at WDI. The original intent of the site was for storage of petroleum by Union Oil. In the early 1920's, Union Oil constructed a 1,000,000 barrel (42 million gallon) capacity concrete reservoir which was used briefly and decommissioned in the late 1920's. The reservoir was subsequently used for unpermitted dumping until 1949, and then used under provisions of a permit thereafter; however, information regarding the exact quantity and type of wastes disposed on-site and in the reservoir is minimal and not detailed. In 1966 the dump was covered with fill and graded to its present condition.

Soil contamination is presently concentrated in the buried reservoir and in several pockets surrounding the reservoir (formerly unlined disposal sumps). Soil is the most contaminated media at WDI. Sludges and oil well drilling wastes are the primary sources of soil contaminants, with metals, volatile organic compounds, semivolatile organic compounds, pesticides and polychlorinated biphenyls (PCBs) also present in soils.

1.2 Site Location

WDI is located in the city of Santa Fe Springs, in Los Angeles County, on a 43-acre parcel of land (Latitude: 37° 57.0' North, Longitude: 118° 03.0' West; Township 2 South, Range 11 West, Section 32 in reference to the San Bernadino Base Meridian). The facility is bordered on the northwest by Santa Fe Springs Road, on the northeast by a Fedco Food Distribution Center (Fedco) and St. Paul's High School, on the southwest by Los Nietos Road, and on the southeast by Greenleaf Avenue (see Figure 1-1, Site Location Map). Residences are located across from the facility on Greenleaf Avenue. The remaining areas on and across Los Nietos Road and Santa Fe Springs Road are occupied by industrial complexes.

1.3 Present Site Conditions

A soil cap covers the former concrete waste reservoir. There are also 361 drums containing contaminated soils from recent site investigations that are stored on-site.

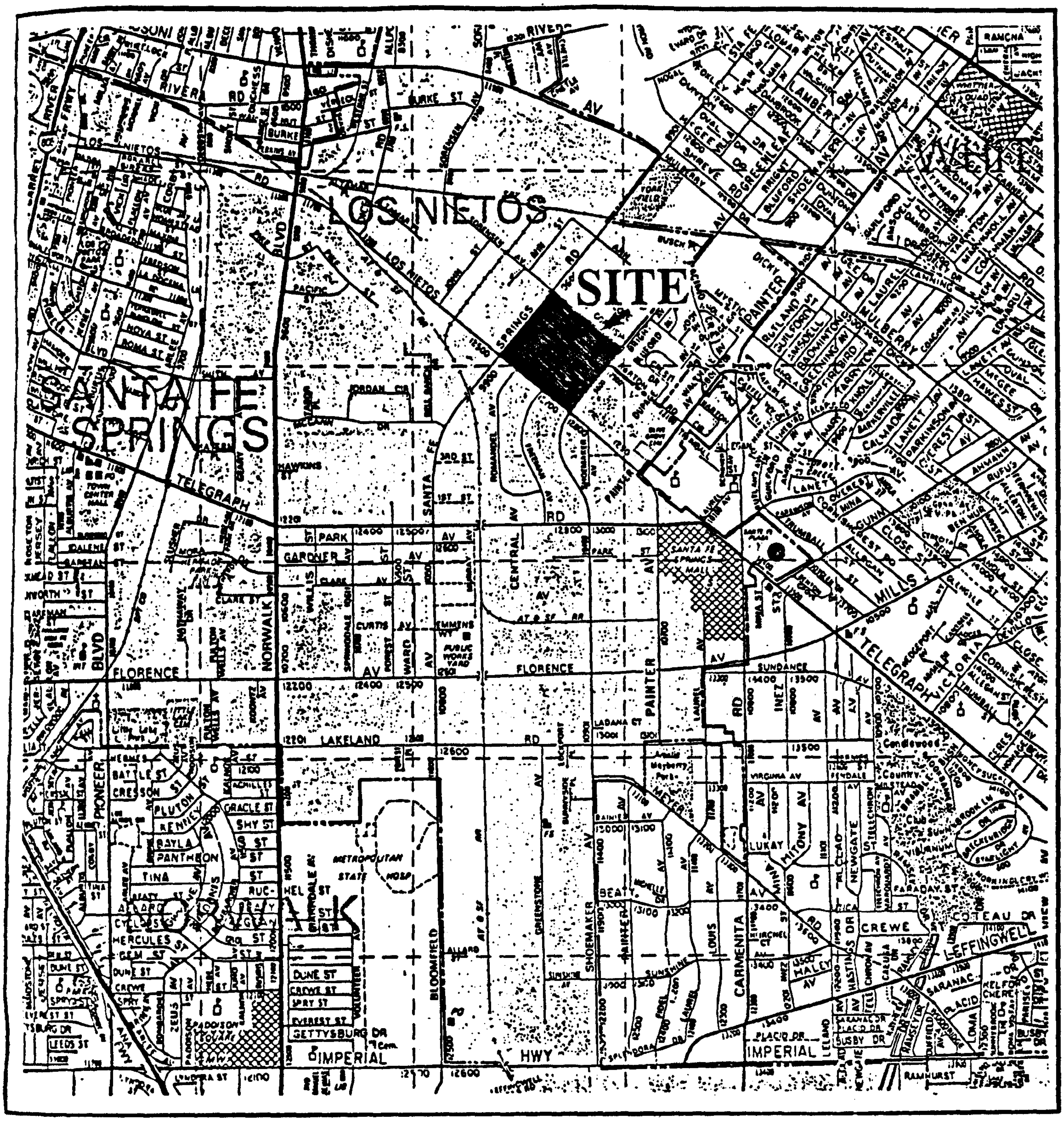


Figure 1-1, Site Location Map

N

SCALE

1"=1/2 mi.

The site is secured by fences, as shown in Figure 1-2, Facility Plan. Both Fedco, located north of the concrete reservoir, and St. Paul's High School, located northeast of the concrete reservoir, are in operation. The current area of investigation encompasses 22 different parcels of land. The parcels are shown in Figure 1-3, WDI Ownership Delineation, and property owners are listed in Table 1-1, Parcel Owners. Due to the location of waste material and results from previous investigations, the properties owned by Campbell, Toxo Spray Dust and the Bennett family are of particular interest. The WDI site has been the subject of many investigations, beginning with geologic investigations in 1971 and leading up to EPA's Remedial Investigation (RI), conducted by Ebasco and completed in 1989. EPA conducted further groundwater investigations in 1992. At present, the area has been fenced by the various owners to create 11 separate areas (see Figure 1-2). Active groundwater and subsurface gas monitoring wells are still present from previous investigations.

1.4 Site History

The primary concern at the WDI site is a 42 million gallon (one million barrel) capacity concrete reservoir, constructed between 1919 and 1928, for petroleum storage. The reservoir was built to support the Santa Fe Springs Oil Field, which was discovered by the Union Oil Company of California in 1919. The reservoir was decommissioned by the oil company in the late 1920's; however, aerial photographs indicate that the reservoir and surrounding area were used for waste disposal between the late 1920's and 1949 (the date WDI was first granted a permit). A 1937 photograph indicates that standing liquid was present outside the concrete reservoir to the northwest, southeast, and south of the concrete reservoir inside dikes, and to the northwest and southwest of the reservoir outside dikes. The photograph also shows disturbed ground and areas of fill along Greenleaf Avenue and Los Nietos Road. A 1945 photograph shows standing liquid in an excavation or pit at the corner of Greenleaf Avenue and Los Nietos Road.

The disposal operations that occurred at WDI have been documented sporadically. Many documents allegedly pertaining to the materials disposed have been destroyed. The most comprehensive information gathered to date has been from aerial photographs, a Potentially Responsible Party (PRP) Search conducted for EPA by ICF Technology in 1987, and files retained by the California Department of Health Services (DHS). A compilation of all known data on the wastes which were deposited at WDI is presented in Table 1-2, Historical Record of Waste Collection, Treatment and Disposal.

On August 3, 1949, Fernando Caneer (owner of the parcel of land on which the reservoir was located) filed an application with the County of Los Angeles to operate a dump in the reservoir for the disposal of solid fill, rotary mud, and other non-acid oil-well wastes. The application was approved and a special permit granted to

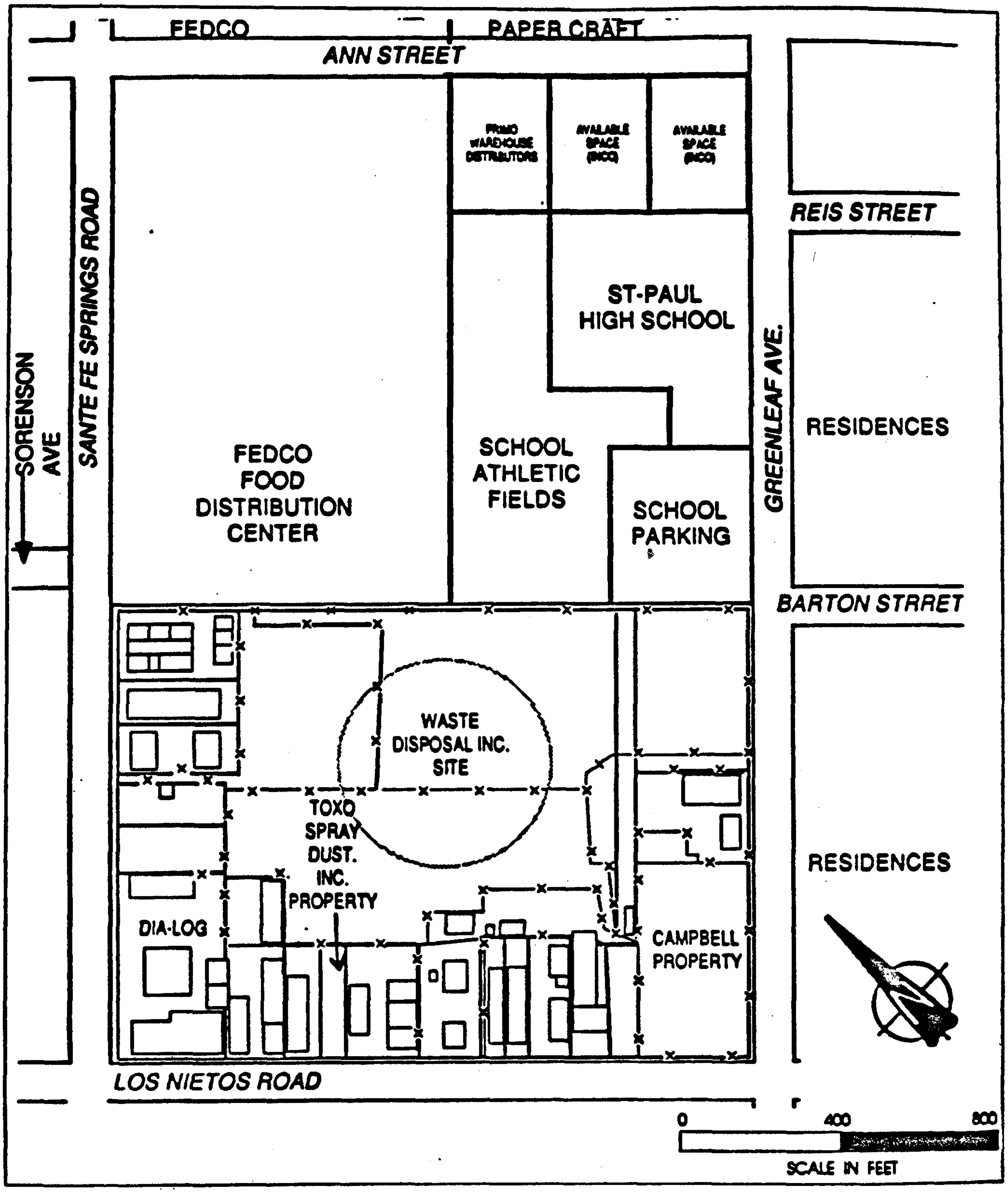


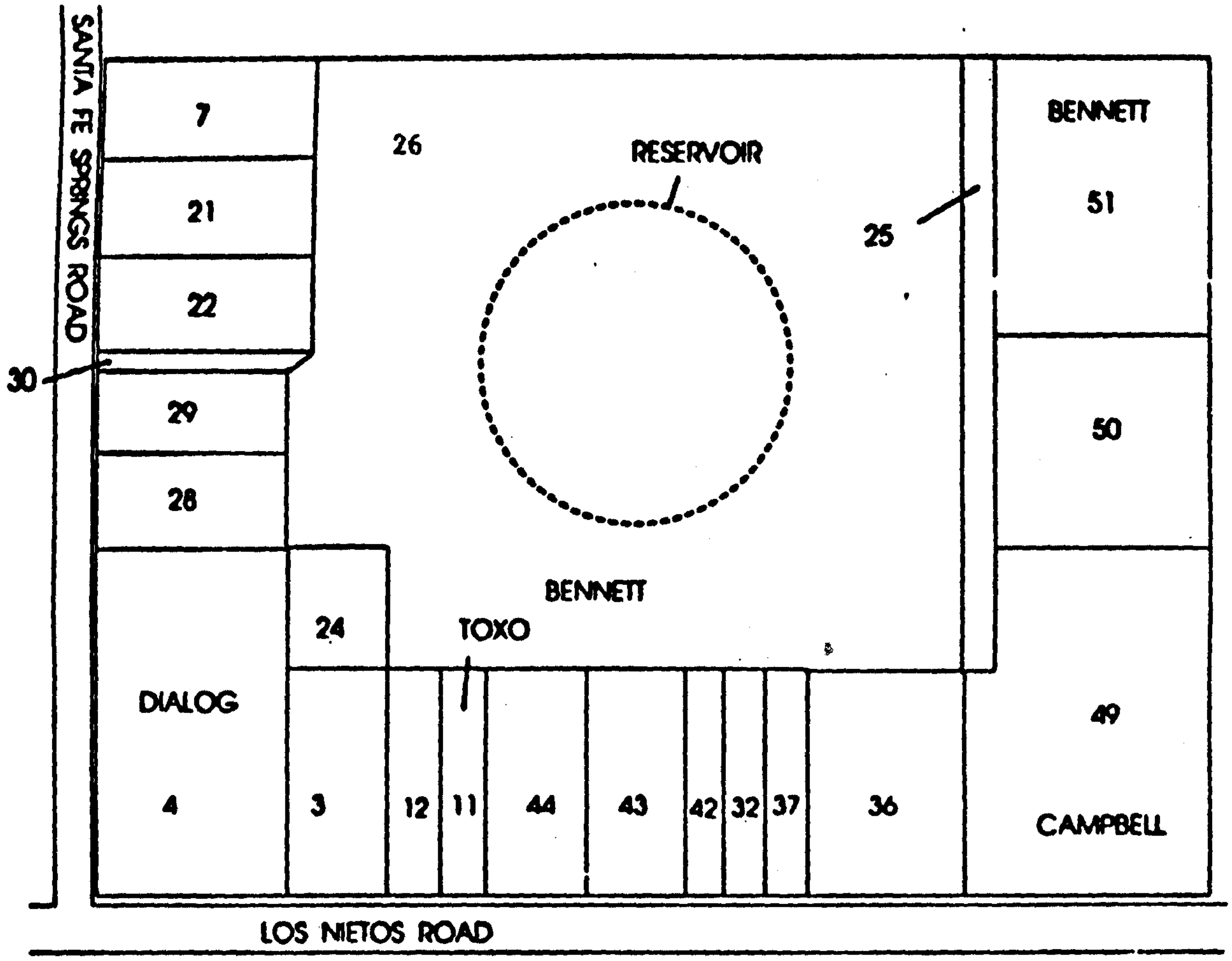
Figure 1-2, Facility Plan

TABLE 1-1

PARCEL OWNERSHIP

Parcel Number*	Owner
3	Holbrook, Leslie, & Raymond (1963)
4	Ford, Alexander Corp. (1965) (DIALOG)
7	Skochdopole, J. (Ready Mix) (1957)/ GM3 Investors (1972)/ C&W Properties (1977)
11	Toxo (1958)
12	Protor, Ovil (1959)
21	Maple, J. (1962)/ Horowitz, R. (1986)
22	Maple, J. (1961)
24	Holbrook (1961)
25	Carter, D. (1960)/ Caneer (1966)/ Campbell (1973)/ Bennett (1978)
26	Carter, D. (1960)/ Caneer (1966)/ Bennett (1977)
28	Mersits (1962)
29	Mersits (1962)
30	Hudson (1964)/ Caneer (1968)/ Bennett (1977)
32	Neptune, D. (1964)
36	Hudson (1965)
37	Cavanagh, M. (1964)/Ortega, A. (1965)/Graziano, A. (1988)
42	Peoples, M. (acquisition date unknown)
43	Timmons, E. (acquisition date unknown)
44	Searing, G. (acquisition date unknown)
49	Campbell, P. (acquisition date unknown)
50	Elliot, W. (acquisition date unknown)
51	Bennett, J. (acquisition date unknown)

* See Figure 1-3 for parcel locations.



1. Information per L.A. Tax Assesor (parcel #8167-002) and Remedial Investigation Report (1989)

2. See Table 1-1, Parcel Ownership, for parcel owners.

Figure 1-3, WDI Ownership Delineation

TABLE 1-2
HISTORICAL RECORD OF WASTE COLLECTION, TREATMENT, AND DISPOSAL AT WDI

WASTE	SOURCE OF WASTE	QUANTITIES	DATES OF DISPOSAL	REFERENCE
Petroleum Refinery Tank Bottoms	Union Oil, General Petroleum, Standard Oil, Rothschild, etc.	Unknown	Unknown	Whittier Daily News (1987, 1988)
Steel Mill Slag	Unknown	Unknown	Unknown	Whittier Daily News (1987, 1988)
Brewery Wastes	Unknown	Unknown	Unknown	Whittier Daily News (1987, 1988)
Cesspool Sewage	Santa Fe Springs Waste Water Disposal Company	Unknown	1958-?	Otteson (1958), Grancich (1958)
Rotary Drilling Mud *	Union Oil, General Petroleum, Standard Oil, Rothschild, etc.	15,000 barrels/week	3/8/50-?	Industrial Waste Discharge Permit 57
Clean Earth, Rock, Sand and Gravel *	Unknown	Unknown	3/8/50-?	Industrial Waste Discharge Permit 57
Paving Fragments *	Unknown	Unknown	3/8/50-?	Industrial Waste Discharge Permit 57
Concrete, Brick, Plaster *	Unknown	Unknown	3/8/50-?	Industrial Waste Discharge Permit 57
Steel Mill Slag *	Unknown	Unknown	3/8/50-?	Industrial Waste Discharge Permit 57
Dry Mud Cake *	Oil field sumps	Unknown	3/8/50-?	Industrial Waste Discharge Permit 57
Acetylene Sludge *	Security Engineering Chicksan Company	200 barrels/week 20 barrels/week	8/5/53-? 8/5/53-?	Fox (1953)
Liquid Residue from Railroad Car Washing Racks and Machine Shop	Holbrook and Sons, Southern Pacific Railroad, B & H Vacuum, Union Pacific Railroad, George Casey Company	Unknown	1/15/62-? 5/9/65-?	Dump Inspection Reports (Moore, 1962, 1965)
Payzone	Unknown	Unknown	11/27/53	LA County Engineer Photo, File I-629
Odor Control Spray	Mr. Dell, LA County, Department of Engineer	Unknown	1958-?	Grancich (1958)
Unspecified Liquid Waste	Archer-Daniels-Midland, B&B Deburring Roberts Company	Unknown	1958-?, 1958/1959-? 1958/1959-?	Committee Against Waste Disposal, Inc. (1958), Coates (1959), Moore (1958), Collins (1959), Medley (1959)

* Permitted Wastes

Source: Remedial Investigation Report

Mr. Caneer, Marvin Pitts, Nollie B. Hudson, and Delmar Carter (all owners of various parcels of land at the WDI site at the time) for the above mentioned purposes.

In March 1950, the County of Los Angeles issued another permit to Whittier Area Disposal Co. (also known as Waste Disposal Inc.) which allowed the disposal of rotary drilling mud, clean earth, rock, sand and gravel, paving fragments, concrete, brick, plaster, steel mill slag, dry mud cake from oil field sumps, and all suitable "solid fill material". At the time, the one-million barrel capacity reservoir was bermed on three sides by an earth dike, with the berm surrounded by a channel. Many unlined ponds and waste handling areas also existed at the time.

In April 1953, WDI's permit was amended to allow 24 hour per day operation of the site. On April 21, 1953, WDI annexed an area located 600 feet north of Los Nietos Road and west of the concrete reservoir for the disposal of drilling mud. Later that year, WDI was granted permission from the County of Los Angeles to accept acetylene sludge for disposal. At that time, WDI was disposing of 15,000 barrels of rotary mud per week and wished to accept 200 barrels per week of acetylene sludge from Security Engineering and 20 barrels per week of acetylene sludge from Chicksan Company.

At least twice during the facility's operation, waste liquids, sludges and muds escaped the concrete reservoir and diking system. In 1956, liquid wastes flowed into the surrounding channel and toward Greenleaf Avenue. In the winter of 1962, liquids containing oily substances seeped through the northerly dike after a period of heavy rainfall and migrated onto the St. Paul's High School athletic fields (see Figure 1-2).

The practice of dumping oil well mud at WDI began as early as 1950, and by 1955 numerous deep sump holes filled with waste material and oil sludge existed in areas outside the reservoir. In 1957, Mr. Caneer was observed pumping liquid from the reservoir to an adjacent unlined waste handling area. After this incident, the ground surface and unlined waste disposal areas surrounding the reservoir were used regularly for the disposal of liquid wastes. According to Dump Inspection Reports from the County of Los Angeles, after the concrete reservoir reached capacity, liquids were disposed on the ground.

WDI also received liquid wastes from adjacent companies. Facilities along the eastern edge of WDI, along Greenleaf Avenue, left ponds of liquid wastes along the southern edge of the WDI site and along the entrance road from Los Nietos Road to the WDI site. Two of these companies were identified as B&B Deburring, and the Roberts Company. Site operations and waste types discharged from these facilities are unknown.

There is evidence indicating that WDI discharged liquids into the Los Angeles County Sewer System as early as 1953. One source states that "wastewater is discharged after suitable treatment, by temporary pipeline into the sanitary sewer." The wastewater referenced in this statement appears to have been discharged into a channel leading to Greenleaf Avenue. Later, a permanent pipe was installed to allow liquids to flow directly to Greenleaf Avenue and into the sewer. A short time after March 1960, a pipe from WDI was connected to the Los Angeles County sewer system with approval from the County. The records of the sewer system of City of Santa Fe Springs, however, do not show a current or former connection from the WDI site.

The present grade of the site was achieved by gradual deposition of solid fill material, starting in October 1958 and ending in 1966. A 1958 photograph shows standing liquid in the reservoir, in the northern corner of the waste handling area surrounding the reservoir, and the area west of the reservoir outside the diking system. By September 1961, the concrete reservoir was 50% full; by November 1962, the reservoir was completely full of solid material, and liquids flowed into the diked areas. In 1964, the site was closed, and final grading of the site with topsoil continued until the end of 1966. Since its closure, several businesses have built buildings on and around the WDI site.

The site was placed on EPA's National Priorities List in July of 1987. To improve site security, a fence was erected around the Campbell property in 1988. The Remedial Investigation was initiated in 1988, with the final report completed in November 1989.

1.5 Local Geology

The WDI site is located northwest of the Santa Ana Mountains, which form the eastern boundary of the Los Angeles Basin. The WDI site is bound on the northeast by the La Habra Syncline, and on the southwest by the Coyote Hills (Santa Fe Springs) anticline in an area commonly referred to as the Santa Fe Springs Plain. This plain is a gently rolling topographic feature that has probably been warped by the Santa Fe Springs - Coyote Hills anticline system and dips gently both to the northeast toward Whittier and to the southeast toward the Downey Plain.

The elevation of the site is approximately 160 feet above mean sea level (MSL). The main portion of the site is situated approximately 10 to 20 feet above the surrounding terrain. Although the land to the west and to the southwest is fairly level, the land to the northeast drops away at a 30 to 50 percent slope and the land to the southeast of the site drops away at a 10 to 30 percent slope. Subsequently, surface drainage from the site is generally toward these areas.

The site-specific geology can be found in the Soil Characterization Report, (one volume of the Remedial Investigation Reports) along with a number of cross-sectional representations. The WDI soil boring logs and cross-sections indicate that WDI strata consist of fluvial deposits. The soils are coarse-grained, occasionally pebbly, channelized sands surrounded in places by finer-grained laterally extensive beds. This suggests that a braided river system was present. The variable thickness (three to 20 feet) and variable lateral extent (30 to 1500 plus feet) of individual channel deposits underlying the site is a result of the continuous active fluvial channel-cutting events.

The detailed cross sections shown in the Soil Characterization Report point out local stratigraphic variations. These variations can be summarized as follows:

- Five to 15 feet of fill material covers most of the WDI site (five feet at the north end and 15 feet at the south end).

- Below the fill material is a silt layer ranging from 10 to 25 feet in thickness which is also present across the entire WDI site.

- Below the silt layer are sandy, pebbly, channelized braided river deposits at least 50 feet thick.

- Strata beneath the WDI site apparently dips two to four degrees to the northwest. This is best illustrated by a five-foot thick clay bed overlying a silt layer present on both sides of the WDI site, and which trends NW-SE. The difference in elevation of the clay bed and silt layer on opposite sides of the site suggests that NW-SE trending sediments are parallel to the direction of dip of WDI strata.

- A clay and silt layer about 10 feet thick and from 30 to 40 feet below ground level is present under approximately 25 percent of the site. This layer is found predominantly at the southeast end of the site and is interbedded with the sandy, pebbly, braided river deposits. This layer may at one time have been deposited over the entire study area.

- Over most of the site the apparent direction of channeling, and therefore, the apparent direction of sediment transport, is in a NW-SE direction. In a general sense, the NE-SW trending cross-sections appear to transact individual channel profiles, whereas the NW-SE trending cross-sections appear to trend parallel to the axis of individual channels. An exception to this apparent NE-SW direction of sediment transport can be found in the eastern corner of the site, where the network of channels is more unpredictable.

- While the order in which these strata occur varies at different locations on-site, the more permeable strata above the water table tend to be most often below less permeable strata. There is no evidence of a confining layer above the water table and available data suggests that one is unlikely. Small localized clay and silt terraces are evident, but appear to be of insufficient size or extent to be useful as a low-permeability barrier for containment or in-situ soil treatment alternatives.

1.6 Hydrology

The WDI site is situated in the Whittier Area of the Central Groundwater Basin. The Whittier area is overlain by the La Habra Piedmont Slope and part of the Santa Fe Springs Plain and Coyote Hills. The known water-bearing sediments, extending to a depth of about 1,000 feet (800 feet below sea level), include recent alluvium and the Lakewood and San Pedro Formations. A part of the Pliocene and older deposits may also contain water of good quality. Electric logs of oil wells indicate fresh water at a greater depth than has been penetrated by water wells. Table 1-3, Depth, Thickness and Geology of Aquifers in the Vicinity of WDI, presents the water-bearing zones that underlie WDI. Groundwater immediately below the WDI site is generally located 48 to 65 feet below the ground surface and from 101 to 108 feet above mean sea level. This places the aquifer approximately 34 to 44 feet below the bottom of the WDI reservoir and 22 to 47 feet below the bottom of the WDI sumps. Figure 1-5, Groundwater Elevation Map, shows the elevation of groundwater at the WDI site during the Remedial Investigation initiated in November 1988. The direction of groundwater flow is generally southwesterly. The groundwater hydraulic gradient is 1:500 or 0.2 percent. The velocity of groundwater flow has been estimated to range from 6-60 ft/yr. The hydraulic conductivities for sandy clay soil and sandy soils at the site are 50 and 500 gpd/ft^2, respectively.

It has not been established that the aquifers in the Lakewood formation (the groundwater immediately below the site) are hydraulically connected with the aquifers in the deeper San Pedro Formation. Early researchers (Department of Water Resources, 1961) concluded, however, that in the vicinity of WDI, the Lakewood and San Pedro Formations may be hydraulically connected. The large number of oil wells in the area and the presence of multi-perforated groundwater wells may also act as artificial conduits of liquids between aquifers. Data collected to date have neither confirmed nor denied the interconnection of aquifers in the vicinity of the WDI site.

Drinking water is not taken from the shallowest aquifer under the WDI site, but from deeper aquifers. Approximately fifty percent of the drinking water for the city of Santa Fe Springs is taken from five wells (perforated in the Lynwood, Sunnyside and Silverado aquifers) in the San Pedro formation in the vicinity of WDI. Four of these wells are located within three miles of the site. The closest well is located approximately 1.5 miles northwest of the site. The well that most closely represents a downgradient supply well is approximately 3 miles southeast, and is perforated in the Sunnyside and Silverado aquifers, at a depth of 760 feet. (The well previously was screened in the shallower Lynnwood aquifer, too, but that screen was closed off due to hydrogen sulfide contamination, which is not related to WDI.) The remaining 50%

Table 1-3
Depth, Thickness, and Geology of Aquifersin the Vicinity of WDI

FORMATION	WATER-BEARING ZONE	THICKNESS (in feet)	DEPTH (in feet)	UPPER ELEVATION (in feet ± msl)	GEOLOGIC CHARACTERISTICS
Lakewood	Bellflower Aquiclude	10-40	70	+ 100	Clay and sandy clay
Lakewood	Artesia Aquifer	20 (max)	---	+ 80	Sand, interbedded clay
Lakewood	Gage Aquifer	30	150	+ 0-50	Sand, interbedded clay
San Pedro	Hollydale Aquifer	10-25	100	+ 85-100	Sand and gravel, small amount of clay
San Pedro	Jefferson Aquifer	20-40	350	---	Sand and gravel, small amount of clay
San Pedro	Lynwood Aquifer	50-100	460	- 300 (at max depth)	Sand and gravel, small amount of clay
San Pedro	Silverado Aquifer	100-200	650	- 500 (at max depth)	Sand and gravel
San Pedro	Sunnyside Aquifer	150-200	1000	- 700 (at max depth)	Sand and gravel, interbedded clay

Source: Adapted from DWR (1961)

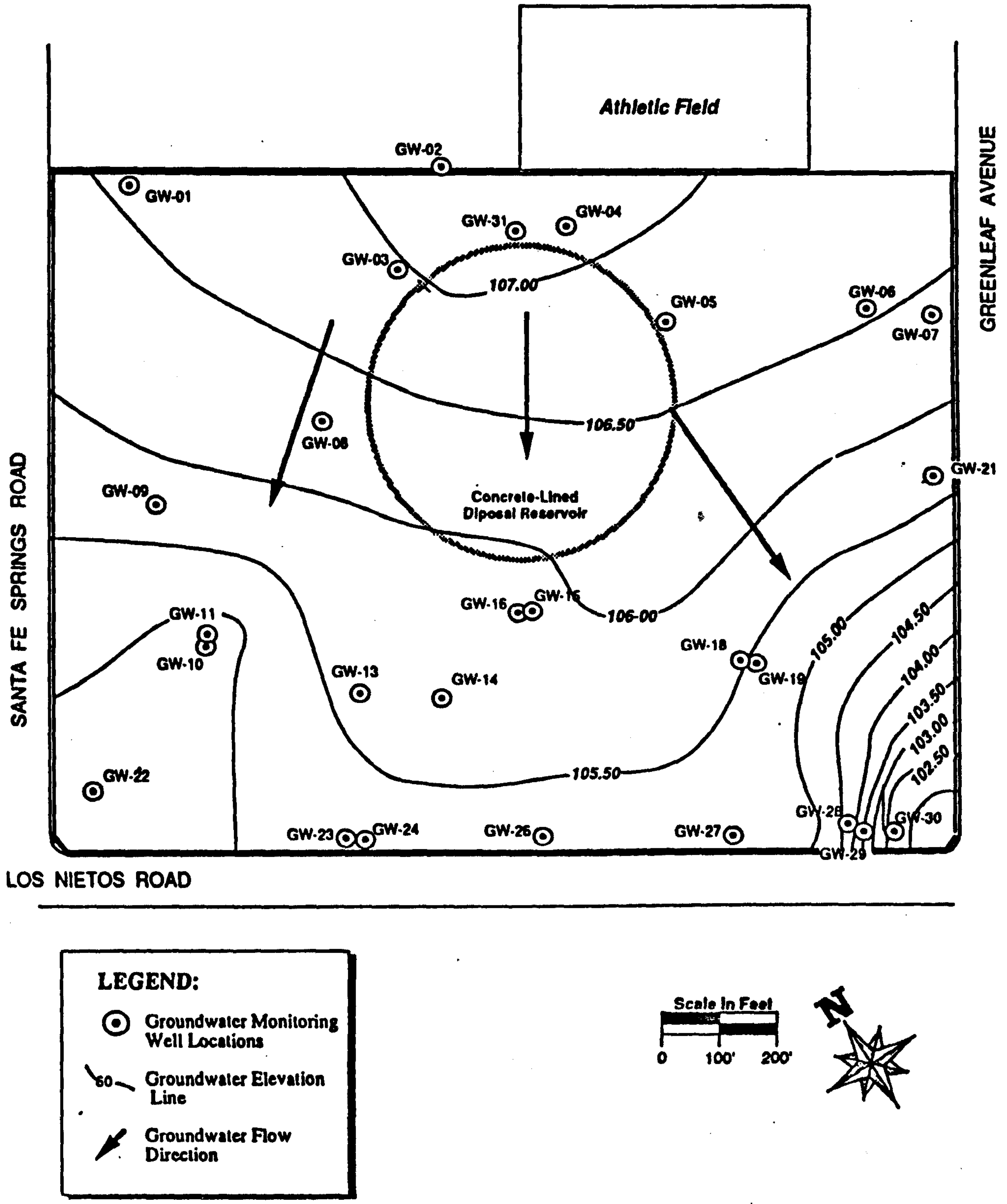


Figure 1-4, Groundwater Elevation Map

of Santa Fe Springs' drinking water supply is purchased from the Metropolitan Water District. Groundwater from the city wells and water purchased from the Metropolitan Water District is fed directly into a piping network, blended, and distributed to 4200 residential and industrial connections.

1.7 Sensitive Environments

Federally endangered species potentially present at the site include the Island Night Lizard, the Slender-horned Spineflower, the American Peregrine Falcon, and the Least Bell's Vireo. However, none of these species have been observed on the site.

1.8 Previous Investigations

The WDI site currently consists of many individually owned parcels of land. Several of these parcels, including the central portion of the site which contains the concrete reservoir and several sumps, have been the focus of previous site investigations. A summary of these investigations is provided in Table 1-4, Summary of Previous Studies Relevant to the WDI Site.

1.8.1 *Geotechnical Investigations Prior to 1984*

Starting in 1971 and ending in 1981, there were three geotechnical investigations performed at the WDI site. None of them were performed in the immediate area of the reservoir, and none involved soil sampling and analyses for contaminants.

1.8.2 *Dames & Moore Investigations (1984-1986)*

Dames and Moore was contracted by the City of Santa Fe Springs Redevelopment Agency in 1984 to perform investigations at the site. The studies conducted were designed to assess the nature and extent of subsurface contamination at the WDI site. These studies focused on the characterization of the soils and subsurface gas in the Toxo Spray Dust area, Campbell property, and the general reservoir area. The study conducted in the reservoir area also included groundwater sampling and analysis at three monitoring wells installed around the perimeter of the reservoir.

Contaminant concentrations found in on-site soils and groundwater during the Dames and Moore Investigation were compared to state regulated limits for hazardous waste (detailed in California Administrative Code, Title 22, Division 4, Chapter 30), and to federal regulations for contaminants in drinking water (detailed in 40 CFR 141, which implements the Federal Safe Drinking Water Act). State regulations have established Soluble Threshold Limit Concentrations (STLC's) and Total Threshold Limit Concentrations (TTLC's) as the criteria for determining a hazardous waste, and a testing procedure for making that determination. Since this procedure (the Waste Extraction Test) was not performed on samples for this investigation, STLC and TTLC

Table 1-4
Summary of Previous Studies Relevant to the WDI Site

CONDUCTED BY	AREA OF STUDY	DATE	PURPOSE	RESULTS
Advanced Foundation Engineering, Inc.	Southwest of reservoir near Los Nietos Road	1971	To conduct a geotechnical evaluation of the site.	Soil investigations indicated that the site's underlying geology consisted of fill material (0-3 feet), clayey silt and silty clay (3-15 feet), and sandy soil (15-20 feet).
Hammond Soils Engineering	Southwest of reservoir near Los Nietos Road	1975	To conduct a geotechnical evaluation of the site.	Fill and soil investigations indicated that the site was underlain by sandy silt and clay with some deleterious material and oil contaminated soil in the northern area (0-7.5 feet), central area (0-8.5 feet), and southern area (0-15 feet).
Moore and Tabor	Northeast corner of Greenleaf Avenue and Los Nietos Road (Campbell Property)	1981	To conduct a foundation investigation.	Soil investigations indicated that the site was underlain by loose fill consisting of silty sand or clayey silt (1-5 feet) and alluvial deposits consisting of interbedded, moderately dense, fine to medium silty sandy and soft to very soft clayey and sandy silt (5-16 feet).
Dames and Moore	The WDI reservoir and the Campbell property areas.	1984	To conduct Phase I remedial investigations.	Four soil borings were drilled and soil samples were collected and analyzed. Boring logs indicated that the site was covered by 4 to 9 feet of fill material underlain by a mixture of clay, silt, and sand to the depth of about 20 feet. Metal concentrations above STLC were found in soil samples. Semi-volatile organics were also detected in several samples.
Dames and Moore	The WDI reservoir and the adjacent athletic field.	1985	To conduct Phase II remedial investigations.	Field investigations included installation and sampling of three monitoring wells in the reservoir area and collection of 35 shallow soil samples from locations around the site. According to the boring logs, the site's geology consisted of clay-silt-sand mixture of varying distributions (up to 25 feet) and sandy-silt and fine to medium grained sand (25-70 feet). A boring log from a waste handling area indicated that the site was underlain by fill material (0-3 feet), mixture (14-22 feet) followed by fine to medium grained sand. Groundwater samples did not show contamination by CAM metals and EPA priority pollutants. Lead concentrations above STLC were detected in several soil samples but similar to background concentrations. No detectable concentrations of priority pollutants were found.

Table 1-4
Summary of Previous Studies Relevant to the WDI Site

CONDUCTED BY	AREA OF STUDY	DATE	PURPOSE	RESULTS
Dames and Moore	Toxo Spray Dust, Inc.	1986	To conduct remedial investigations.	Soil and subsurface gas samples were collected and analyzed. The site was found to be contaminated by pesticide compounds. As a result, the Toxo Spray Dust building and 16 cubic yards of soils were removed and transported to a Class I landfill. Methane and non-methane gases also appeared to be present at the site.
Dames and Moore	Campbell Property	1986	To conduct remedial investigations; to locate and estimate the volume of waste handling areas.	Soil and soil-gas investigations and CPT (Cone Penetrometer Test) soundings were conducted. Moderate levels of semi-volatile organics were found in soil samples. Analysis of soil-gas samples indicated the presence of methane and non-methane gases. Results of CPT data were used to estimate volume of waste handling materials.
John L. Hunter and Associates	Campbell Property	1987	To conduct soil sampling following unauthorized waste discharge.	Four soil samples were collected at waste discharge areas. Metal concentrations in the soil samples were below TTLC limits. The STLC of samples was exceeded for several metals. Nitrate concentration varied from 9 to 3,990 ppm.
Ebasco	Reservoir area, Campbell Property, Toxo Spray Dust Property, and adjoining properties.	1989	Remedial Investigation	100 soil borings performed, 5 high volume TSP air samples used, 27 groundwater monitoring wells installed, 26 sub-surface gas monitoring wells installed. Air quality on-site was not above background levels. Soils contained metals, volatile organics, semi-volatile organics, pesticides/PCBs, in concentrations above background levels. Subsurface organic gases were found. Volatile organics, semi-volatile organics, and metals were found in groundwater.
Environmental Protection Agency	11 Groundwater Wells	1992	To confirm previous analytical results and increase the data base for organic and inorganic parameters in the shallow aquifer at the site.	EPA sampled 11 wells over three quarters in 1992 to verify the levels of contamination in the groundwater. The data collected was found to be consistent with previous investigations at WDI with respect to both the hydrology and chemical properties. The presence of volatiles and metals in the shallow aquifer was confirmed.

values are not valid for comparison to sample values. Federal regulations have established Maximum Contaminant Levels (MCL's) that govern the amount of contamination allowed in drinking water, which is defined as the water that flows from a tap, not the water that exists in aquifers.

1.8.2.1 *Toxo Spray Dust Area*

According to aerial photos of the WDI site, Toxo Spray Dust first owned and operated a pesticide manufacturing and storage facility adjacent to the WDI reservoir in 1953. On July 1, 1986, Dames and Moore collected two samples from the flooring in the former dry-mix area of the Toxo Spray Dust production building. On July 9, 1986, six shallow soil vapor probes were installed in the near vicinity.

Detailed results of this investigation are presented in the WDI Soil Characterization Report. Floor samples contained methylparathion, ethylparathion, endosulfan I, and endosulfan II. One of the soil-gas samples contained 231,000 ppm (23.1% by volume in air) of methane and 597 ppm of total non-methane hydrocarbon as hexane. The soil samples contained malathion, ethylparathion and endosulfan I. In addition, concentrations of aldrin, 4,4'-DDE and 4,4'-DDT that exceeded the TTLC limits for hazardous waste were detected. This investigation resulted in DHS requiring that the Toxo Spray Dust building be demolished and hauled to a Class I landfill for disposal. Approximately 16 cubic yards of soil were excavated from the site. On March 31, 1987, this material was disposed at a Class I landfill owned and operated by Chemical Waste Management, Inc. in Kettleman Hills, California.

1.8.2.2 *Campbell Property*

Dames and Moore conducted soil-gas sampling and Cone Penetrometer Test (CPT) soundings on the Campbell property in May and June 1986. The purpose of these investigations was to better estimate the extent of disposal areas and associated soft material on-site. The shallow vapor probes were used to assess the nature and concentration of organic vapors in the subsurface soils. The results of soil-gas analyses indicated methane concentrations of 9,500 and 11,200 ppm in two of the samples and a non-methane hydrocarbon concentration of 29 ppm in only one sample.

Each of the CPT soundings from the Campbell property were plotted and interpreted. The volume of waste and overburden materials was estimated to be between 10,000 and 16,000 cubic yards. The CPT soundings show the presence of very soft sump materials, possibly including desiccated muds and loose fill. Two approximations for the horizontal extent of the very soft material were made. The first estimated contaminated area contains very soft material and has approximate dimensions of 100 feet by 175 feet with an average thickness of ten feet. Very soft material was encountered as deep as 18 feet. Including the overburden, the first volume estimate for the contaminated area was 10,000 to 12,000 cubic yards. A second estimate for the contaminated area was made and assumed to represent the margin of the sump, with generally shallower depths of sump material. The additional volume was estimated to be about 2,000 to 4,000 cubic yards.

Dames and Moore also drilled six soil borings on the Campbell property, ranging in depth from 16.5 to 21.5 feet, and sampled every 2.5 feet. Three borings (DM-4, DM-5, and DM-6) were located adjacent to the WDI site in order to evaluate whether hazardous chemical compounds had migrated across the property boundary. Moderate levels of naphthalene, di-n-butyl phthalate and 2-methylnaphthalene were found in one boring at a depth of six feet. Another boring contained moderate to high concentrations of naphthalene, ethylbenzene, fluorine, phenanthrene, and 2-methylnaphthalene between 8.5 and 11 feet. Di-n-butyl phthalate, isophorene and chrysene were found at 11 feet. A third boring contained relatively high concentrations of naphthalene, 2-methylnaphthalene, fluorine, and phenanthrene at 16 feet. Detectable concentrations of di-n-butyl phthalate were found. The pH of the soil samples was found to be between 7.9 and 8.4. Metals were also detected, but were not quantified.

Four soil samples were collected from the Campbell property in December 1987, following the unauthorized discharge of plating solutions to the ground. All samples were analyzed for priority pollutant metals, nitrate and pH using EPA Method 9040. Samples indicated that the concentrations of chromium, nickel, copper, zinc, arsenic, cadmium and lead exceeded their STLCs, but a Waste Extraction Test was not performed to directly compare the results. The concentration of nitrate varied from 9 to 3,990 ppm, and the pH of the samples varied from 5.6 to 7.9.

1.8.2.3 *Reservoir Area*

In September 1984, Dames and Moore drilled four borings in the reservoir area (one in the center of the concrete reservoir and three around the perimeter of the reservoir). The borings were terminated at depths ranging from 18.5 to 23.5 feet, and soil samples were collected every 2.5 feet. The concentrations of organic vapors were measured to determine which samples should undergo laboratory analysis. Selected samples were analyzed for California Assessment Manual (CAM) metals and EPA priority pollutant organics.

In March 1985, Dames and Moore collected 35 shallow soil samples from the WDI site, the St. Paul High School athletic field, and a vacant lot approximately 1,300 feet to the northwest of the WDI site. The two samples from the vacant lot were used to determine the background concentration of metals. These samples were collected from a depth of one foot, field tested for pH and organic vapors, and analyzed by a laboratory for CAM metals. Two of the samples were also analyzed for EPA priority pollutants. Analyses showed that the borings contained varying levels of barium, cadmium, copper, lead, mercury, nickel, silver, vanadium and zinc, many of which were above hazardous waste levels.

Samples from the reservoir boring also contained ethylbenzene, tetrachloroethene, toluene, trichloroethene, total xylenes, naphthalene and phenanthrene. Borings surrounding the reservoir contained ethylbenzene, total xylenes and naphthalene. Unfortunately, the dilution of highly contaminated samples resulted in an increase in detection limits for many contaminants. This factor, combined with the compositing and analyzing of soil samples over a depth range of as much as 12.5 feet, made it difficult to accurately characterize the extent and the concentration of the organic contaminants.

The surface soil samples were found to contain lead concentrations at levels that exceeded the STLC, but were generally similar to background concentrations. Concentrations of barium, copper and vanadium were found in concentrations below the STLC but were not found in background samples. Neither of the two surface samples analyzed contained detectable concentrations of priority pollutants.

To assess groundwater contamination, three shallow monitoring wells were installed around the reservoir (one upgradient and two downgradient). The initial attempt to install one of the downgradient wells was abandoned when liquids were encountered at a depth of five feet. Black oily (solid) materials were also encountered during the drilling of the upgradient well. A sample of the materials from these areas was collected and analyzed for EPA priority pollutant organics. Water samples were also collected from the three wells and analyzed for EPA priority pollutant organics and CAM metals. Since one of the downgradient wells was located near a pesticide storage area, the water sample from this well was also analyzed for organochloride pesticides and PCB's. None of the water samples contained detectable concentrations of either CAM metals or EPA priority pollutants. One of the downgradient wells did contain 12 ppb of chlordane, which exceeds the DHS action level for chlordane in drinking water.

1.8.3 *Remedial Investigation (1988-1989)*

Ebasco was tasked by EPA to perform a Remedial Investigation (RI) after site listing on the NPL. The location and configuration (size and composition of parcels), history and results of previous investigations at WDI prompted Ebasco to conduct an extensive field investigation. The major components of the field investigation are presented in Table 1-5, Major Components of EPA Field Investigation Program. During 1988 and 1989, the investigations detailed in Table 1-5 were performed.

Boundary, topographic, and location surveys were conducted prior to initiating field sampling activities. During these surveys, boring and well locations were established, a datum point for subsurface investigations was established, site drainage patterns were identified, and geologic anomalies were noted.

Several geophysical surveys, including electromagnetic conductivity (EM), CPT and ground-penetrating radar (GPR), were also conducted prior to field sampling activities in order to locate the concrete-lined reservoir and find drilling obstructions, and characterize the WDI waste handling and deposition areas. (These areas had previously been identified from aerial photos. See Figure 1-6, Waste Handling Areas 1-8 as Defined by Aerial Photos.) Final interpretations of the data produced during these tests yielded estimates of depth, relative soil densities and strengths, and a preliminary estimate of the horizontal extent of WDI waste handling areas. The information was presented in the WDI Soil Characterization Report.

To monitor air quality during on-site activities, a meteorological station and five high-volume total suspended particulate (TSP) air samplers were used (see Figure 1-7, High Volume Air Particulate Monitoring Stations). Prior to intrusive field operations, TSP sampling was conducted continuously, 24 hours per day for six days, to establish baseline conditions. TSP sampling was also conducted continuously, 24 hours per day, during each work week (six day period) of field operations.

In order to evaluate the extent of subsurface soil contamination, 100 soil borings were drilled to a depth of 35 feet at specified locations around the site (see Figure 1-8, Soil Boring Locations). Approximately 37 of these borings were drilled in areas where contaminated liquids were deposited in unlined sumps. Some borings were located outside of the waste handling areas to determine the extent of contamination migration. Thirteen of the borings were drilled within the concrete reservoir area, and six borings were drilled on St. Paul High School's athletic field.

To determine the extent of groundwater contamination on-site, 27 borings were converted into groundwater monitoring wells. The location of these wells is shown in Figure 1-9, Groundwater Monitoring Well Locations. Of the 27 groundwater monitoring wells installed, 21 were shallow wells designed to sample the uppermost aquifer. These wells were completed at the water table to a depth of approximately 55-70 feet. The remaining wells were completed to deeper depths.

A subsurface gas investigation was performed by converting 26 soil borings into subsurface gas monitoring wells. The locations of the subsurface gas monitoring wells are shown in Figure 1-10, Subsurface Gas Well Locations. The subsurface gas samples were analyzed for basic gases and trace contaminants. A total of 28 samples were submitted for laboratory analysis.

The results of the RI/FS can be grouped into two general categories, (1) physical information regarding all the subareas, and (2) information regarding the extent of contamination in the subareas. The information regarding the physical characteristics of the subareas (see Figure 1-6) are presented in Table 1-6, Physical Characteristics of WDI Subareas, and the information regarding extent of contamination is presented in Section 1-9.

1.8.4 *EPA Groundwater Investigation*

As the final effort in the Remedial Investigation, EPA collected groundwater samples from 11 wells during three sampling events in February, May, and August of 1992. Prior to this investigation, groundwater at WDI had been sampled twice to characterize contamination. The objective of the 1992 sampling effort was to confirm previous analytical results regarding contamination of the shallow aquifer at the site.

Eleven wells were sampled and analyzed for volatiles, semi-volatiles, and inorganics. Detailed analyses of the results may be found in the 1992 Groundwater Monitoring Report, Waste Disposal, Inc., of January 1993. The report concludes that the data gathered during the 1992 monitoring were consistent with previous investigations at WDI regarding both hydrology and chemical properties, but reached no conclusion regarding potential sources of groundwater contamination. Some further investigation must be conducted to fully characterize the extent of groundwater contamination.

1.9 Extent of Contamination

Since the RI was the most recent and most extensive investigation to date, the extent of contamination at WDI is based primarily on its findings. The Final Remedial Investigation Report of November 1989 (by Ebasco) should be referred to for a detailed description of the contaminant levels. The contamination present on-site at WDI exists in the soil and groundwater matrices, and in the form of subsurface soil gas. Present in on-site soils are large amounts of oil well drilling muds and sludges and waste products, metals, low concentrations of volatile organic compounds and semivolatile organic compounds, low concentrations of pesticides and PCB's, and lead. Methane is the most prevalent subsurface gas, with the highest concentrations found in the reservoir area. Groundwater samples were found to contain four metals (aluminum, iron, manganese and selenium) in concentrations above MCLs, as well as volatile organic compounds. Trichloroethene was detected in one groundwater sample at 18 ppb, and also in off-site background wells. On-site background samples did not yield detection of volatile or semivolatile organic compounds. Ambient air was evaluated during the RI; however, the data was not used in the Risk Assessment performed after field activity because of quality assurance problems. Therefore, the air sampling proved only that RI field activities did not worsen local air quality.

Table 1-5 Major Components of EPA Remedial Investigation Program		
COMPONENT	**OBJECTIVE**	**METHOD**
Boundary, Topographic, and Location Surveys	· To define site boundaries. · To develop a topographic map showing site drainage patterns. · To establish location and elevation of various features, soil borings, and monitoring wells, etc.	· Distance and elevations surveys were conducted by a theodolite and electronic distance-measuring device to an accuracy of ± 0.1 feet.
Ambient Air Monitoring	· To monitor air temperature wind direction and particulate matter emissions during field activities.	· An air-monitoring tower was installed in the reservoir area. Temperature & wind direction were measured and recorded. Particulate matter concentrations were assessed.
Geophysical Investigation	· To locate the concrete reservoir, waste handling areas and underground facilities prior to drilling.	· Electromagnetic (EM) survey was conducted on a 100 x 100 foot grid on the site. · Ground penetrating radar (GPR) was used to confirm the data or resolve discrepancies with the EM data. · Cone Penetrometer Test (CPT) survey was used to confirm WDI disposal areas.
Soil Investigation	· To estimate the nature and extent of soil contamination. · To provide data required for estimating contaminated soil volume. · To provide data needed to assess health risks and evaluate transport and fate of contaminants.	· 100 soil borings were installed to a minimum depth of 35 feet in and around suspected contaminated areas. · Lithologic logs of all borings were kept. · A minimum of three samples per boring were collected for laboratory analysis. · Soil samples were tested with an explosimeter, and OVA and HNu in the field.
Groundwater Investigation	· To estimate the nature and extent of groundwater contamination. · To define the hydrogeologic conditions at the site.	· 27 borings were converted to groundwater monitoring wells. · Water levels and several groundwater properties were measured and recorded. · Groundwater samples were collected for laboratory analysis.
Sub-surface Gas Investigation	· To estimate the nature and extent of sub-surface gas contamination.	· 26 borings were converted to sub-surface gas wells. · Samples were collected from these monitoring wells for laboratory analysis.

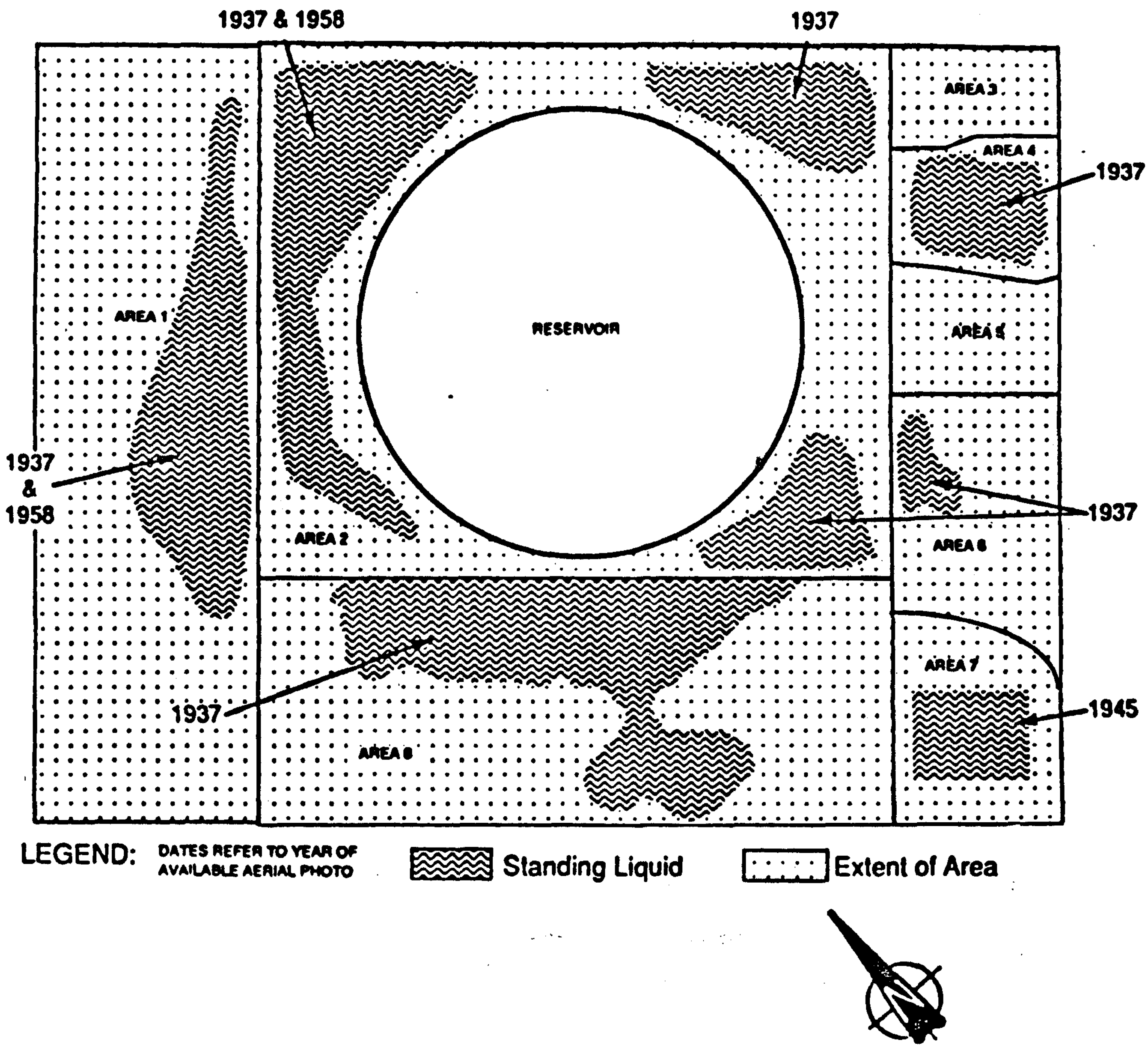


Figure 1-5, Waste Handling Areas 1-8 as Defined by Aerial Photos

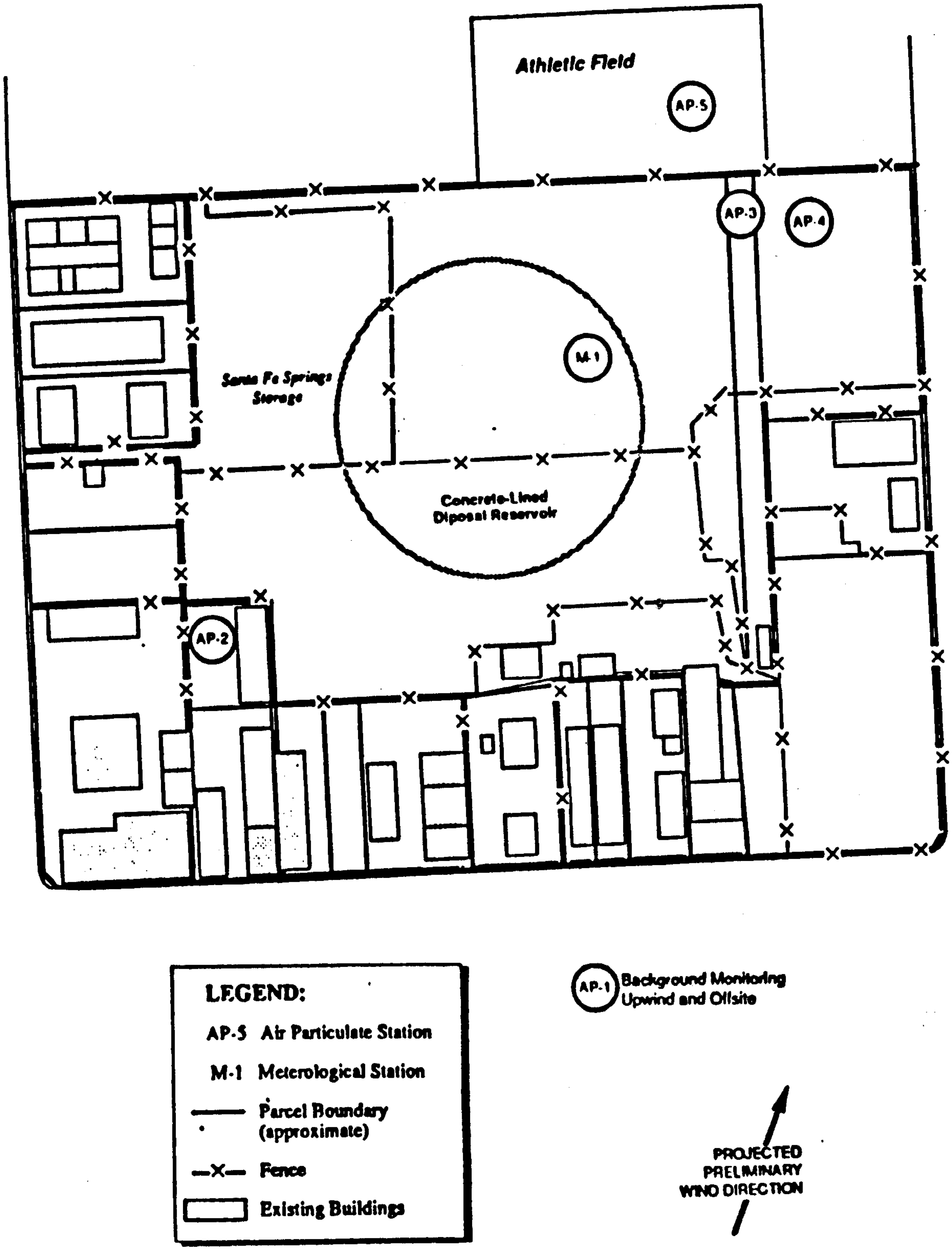


Figure 1-6, High Volume Air Particulate Monitoring Stations

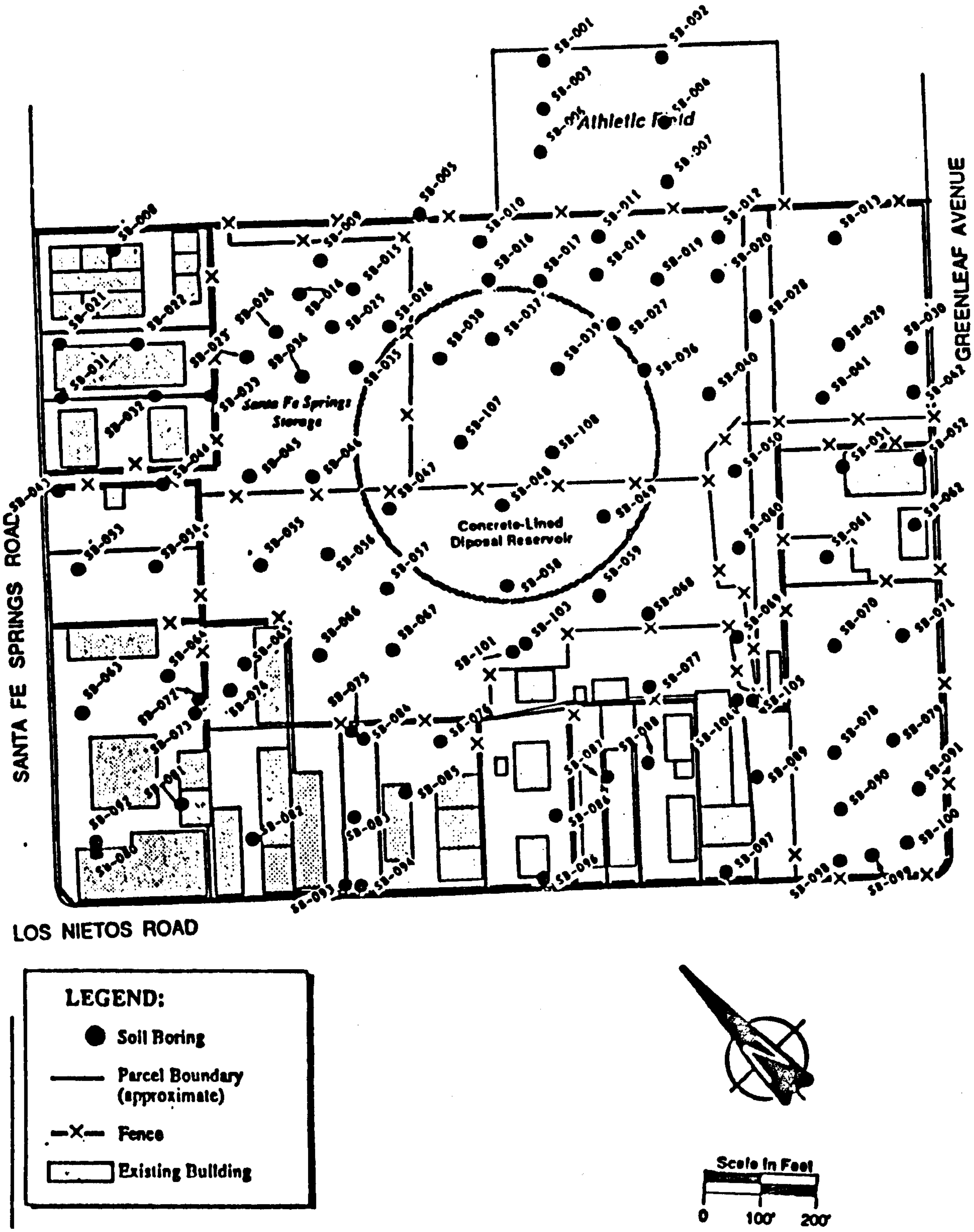


Figure 1-7, Soil Boring Locations

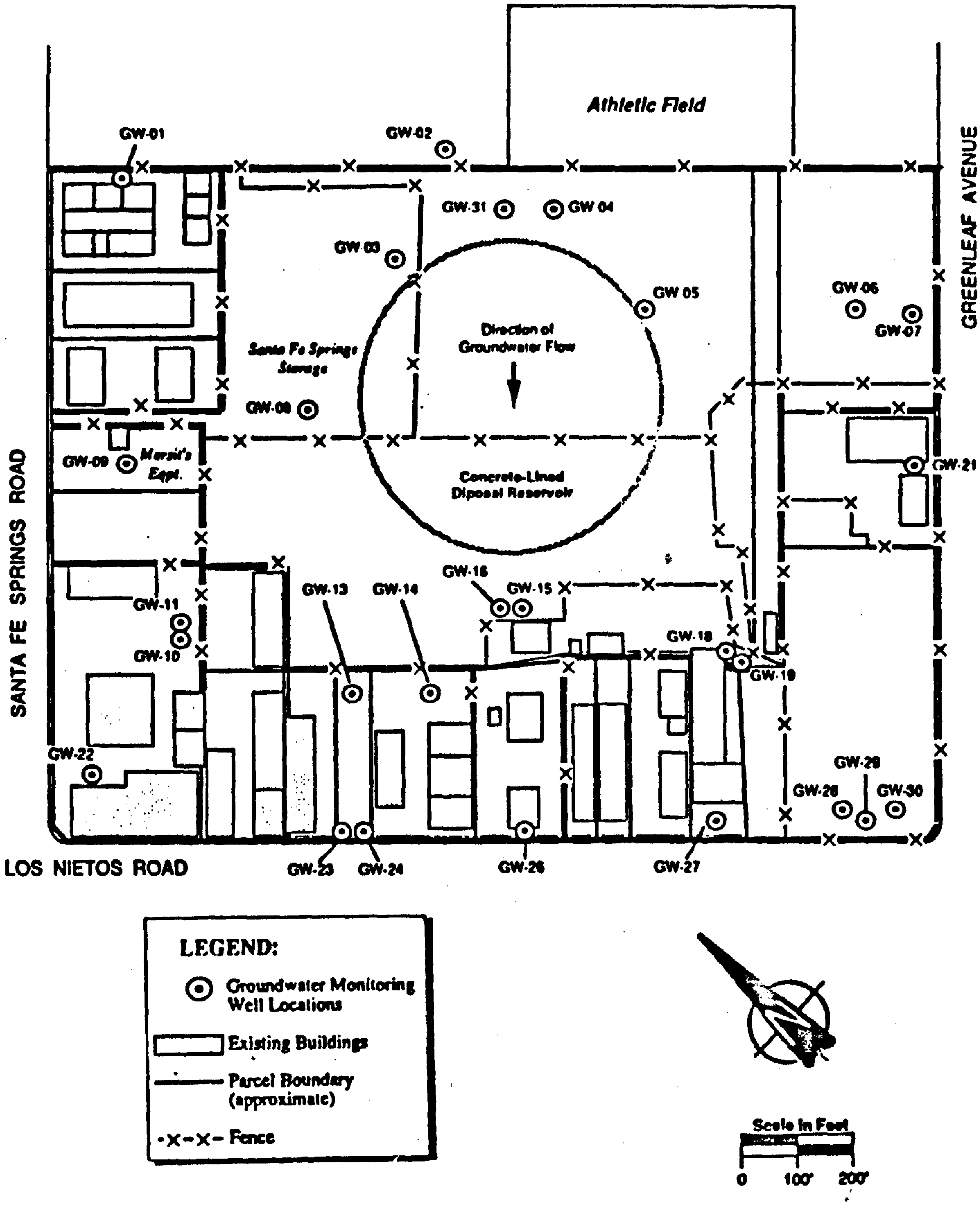


Figure 1-8, Groundwater Monitoring Well Locations

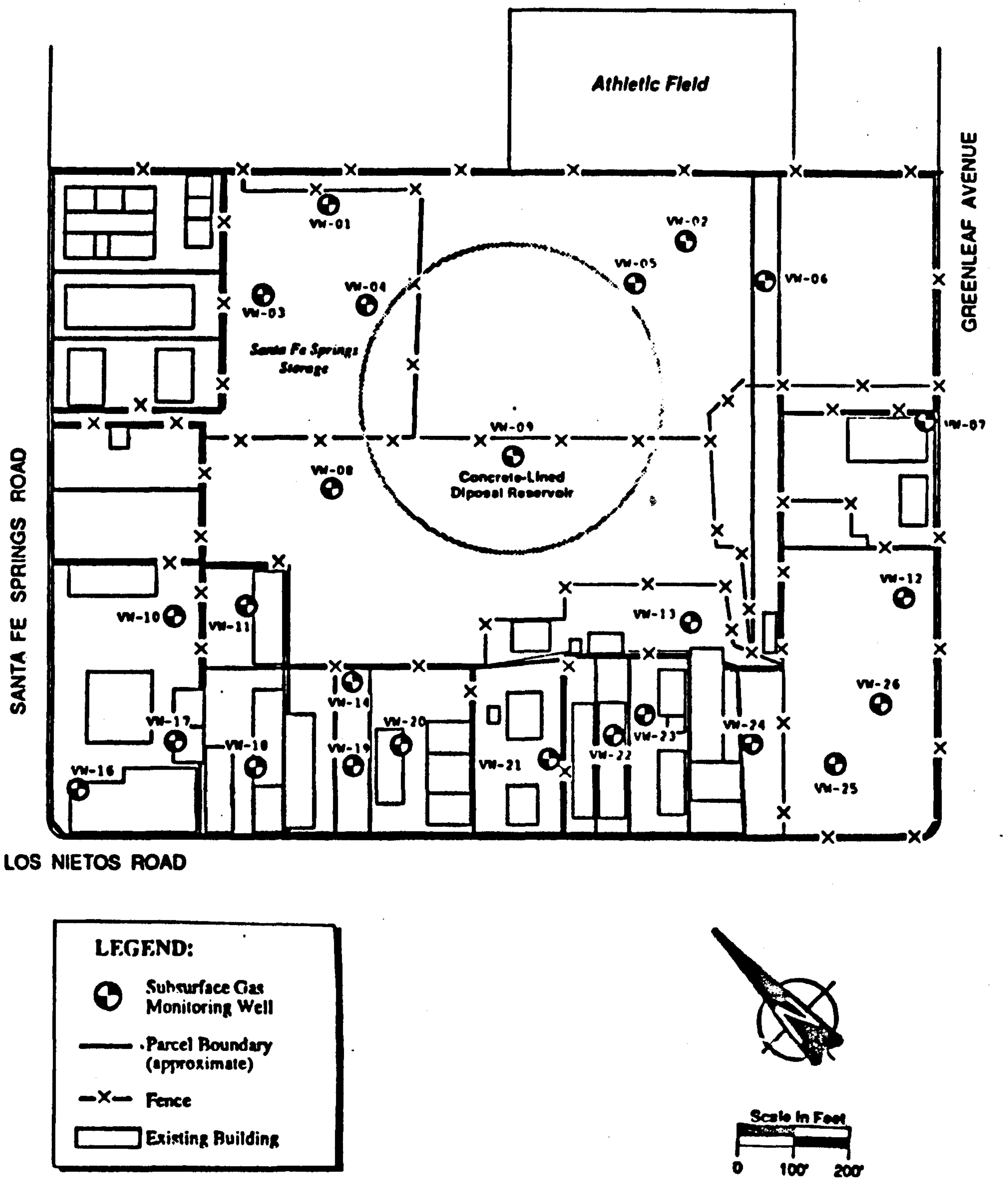


Figure 1-9, Subsurface Gas Monitoring Well Locations

Table 1-6
Physical Characteristics of WDI Subareas*

WASTE HANDLING AREA **	SOIL BORINGS WITHIN AREA	PHYSICAL DESCRIPTION
Reservoir	SB-26, SB-35, SB-37, SB-38, SB-39, SB-47, SB-48, SB-49, SB-57, SB-58, SB-59, SB-107, SB-108	The WDI Reservoir is circular, concrete, approximately 585 feet in diameter. The concrete sides of the reservoir slope inward, and its concrete bottom is from 18-23 feet below ground surface. Surface topography is nearly flat, ranging from 5-10 feet above the rest of the site. Artificial fill material covering the reservoir ranges from 5-15 feet thick. Below the fill material is predominantly "black sludge". Below the base of the reservoir is a few feet of silt underlain by sand. Estimated volumes of waste and fill materials are respectively 174,000 and 58,000 cubic yards.
1	SB-21, SB-22, SB-31, SB-32, SB-33, SB-43, SB-44, SB-53, SB-54, SB-63, SB-64, SB-72, SB-73, SB-80, SB-81, SB-92	Rectangular shape in plan view with dimensions of 300 x 1050 feet. Located along the western border of the site. Topography slopes to the west from 158 to 153 feet above MSL. Stratigraphy below area is characterized by sand and silt with interbedded clays. Fill material ranges from 1-5 feet thick. Aerial photos reveal standing liquids were once present. Most contaminants are found at the eastern half of the area between 5 and 20 feet below the surface. Approximately 48,000 cubic yards of waste material and 16,500 cubic yards of fill are present.
2		Consists of the areas surrounding and adjacent to the reservoir. Perimeter is 725 x 825 feet. Elevation varies from 165 to 159 feet above MSL. Area has been divided into sections described below. Estimated volumes of waste and fill materials are 150,000 and 54,000 cubic yards.
2	· **Northwest Corner** SB-9, SB-14, SB-15, SB-23, SB-24, SB-25, SB-34, SB-45	Aerial photos indicate liquid was present. Borings reveal 5-15 feet of fill material. Below the fill material is contaminated material ranging from 5-20 feet below surface.
2	· **Northeast Corner** SB-18, SB-19, SB-20, SB-40	Aerial photos show standing liquid was present. Borings reveal 5-15 of fill material. Below the fill material is contaminated material ranging from 5-20 feet below surface. Clay layer is15-20 feet below surface.
2	· **Southwest Corner** SB-55, SB-66, SB-67	Contains black sludge and some free liquid. Fill material ranges from 5-10 feet thick and is underlain by 10-15 feet of black sludge. North and east sections underlain by a clay bed, south and west sections underlain by sand, silt.
2	· **Southeast Corner** SB-50, SB-60, SB-68, SB-69	Aerial photos show that standing liquids were present. Fill material ranges from 5-10 feet thick and is underlain by 10-15 feet of contaminated material. Silt is present below the area to 20 feet, which is underlain by sand.
3	SB-13, SB-28	Rectangular shape in plan view with dimensions of 250 x 100 feet. Located at the eastern corner of the site. Borings located on perimeter of area. Area apparently covered with about 10 feet of fill (9,500 cubic yards). Aerial photos show no standing liquid present.

Table 1-6
Physical Characteristics of WDI Subareas*

WASTE HANDLING AREA **	SOIL BORINGS WITHIN AREA	PHYSICAL DESCRIPTION
4	SB-29, SB-30, SB-41, SB-42	Roughly rectangular shape in plan view with dimensions of 300 x 220 feet. Located near northwest corner of site. Topography slopes to east from 165 to 154 feet above MSL. Fill material ranges from 5-10 feet thick. Contaminated material is not found at eastern edge of area. Contaminated material ranges form 5-20 feet below surface. Below this area silt and clay grade downward into sand at 25 feet below ground surface. Estimated volumes of waste and fill materials are respectively 34,000 and 9,500 cubic yards.
5	SB-51, SB-52	Rectangular shape in plan view with dimensions of 250 x 125 feet. Located in the center along the eastern boundary of the site. Five feet of artificial fill covers the area. No standing liquids were identified in aerial photos. The area borings contained no visible contamination. Approximately 5,800 cubic yards of fill material cover the area.
6	SB-61, SB-70, SB-71, SB-79	Roughly rectangular shape in plan view with dimensions of 300 x 320 feet. Located toward the southeastern corner of the site. Topography relatively flat varying from 156 to 159 feet above MSL. Fill material from surface to 5 feet, underlain by waste material to 15 feet. Below area is sand and silt. Aerial photos reveal some standing liquid was present. . Estimated volumes of waste and fill materials are 12,000 and 11,000 cubic yards respectively.
7	SB-78, SB-90, SB-91	Roughly rectangular shape in plan view with dimensions of 300 x 190 feet. Located in the southeastern most corner of the site. Graded with no significant topography. Area covered with 5-10 feet of silty clay and rubble fill, which is underlain by 10 feet of contaminated materials (mainly drilling muds). Perimeter borings exhibit no visible signs of contamination. A 1945 aerial photo shows liquid waste present. The contaminated soil is at depths between 10-20 feet and has an estimated volume of waste and fill materials of 3,900 and 5,700 cubic yards respectively.
8	SB-75, SB-76, SB-77, SB-83, SB-84, SB-85, SB-86, SB-87, SB-88, SB-104, SB-105	Rectangular shape in plan view with dimensions of 830 x 300 feet. Occupies southern edge of site. Average elevation range of approximately two feet. Many small businesses cover the area. Generally, fill is 5 feet thick, underlain by waste material 15-20 feet deep. Waste material is underlain by sand and silt down to 50 feet. Southern half of area appears free of contamination. Aerial photos suggest north area contained standing liquid . Approximately 85,000 cubic yards of waste and 36,000 cubic yards of fill are at the area.

* Information taken from Remedial Investigation Report (1989)
** See Figure 1-6 for waste handling area locations

1.9.1 *Ambient Air Quality*

Ambient air sampling was conducted during the RI for one week prior to on-site work in order to establish background concentrations. Ambient air sampling was also conducted during RI field activities (approximately two months) and compared with the background concentrations. Various metals were detected in all samples. However, there was no significant change in particulate concentrations or the inorganic constituents of the samples collected between the baseline period (the week prior to the investigation) and those collected during remedial investigation activities at the WDI site. An air despersion model was used to predict risk associated with inhalation of airborne contaminants, but the Endangerment Assessment did not use the ambient air data because of quality assurance problems.

1.9.2 *Soil Contamination*

The remedial investigation generated a large quantity of data which can be found in the Final Remedial Investigation Report, November 1989. Since St. Paul's High School and Fedco are located upgradient of the site, and are assumed to be free of contamination from any of the spill areas or the reservoir, samples were taken from these areas and analyzed to establish background concentrations. These background concentrations may be found in Table 1-7, Background Concentrations of Metals in Soils at WDI.

The primary contaminants at WDI are the drilling muds and oil-field, petroleum-based wastes appearing as black oily material or tar-like sludge. Soil samples were not collected for laboratory analysis of total petroleum hydrocarbons (TPH), but soil from many areas of the WDI reservoir and waste-handling areas were observed to be contaminated during the RI. The State of California and the Regional Water Quality Control Board generally recognize any petroleum hydrocarbons levels over 1000 ppm as hazardous and suggest monitoring and/or venting of soils with TPH values which exceed 100 ppm. The State of California does not, however, have a promulgated standard for the concentration of TPH in soils.

1.9.2.1 Overview of Contamination in Soils

The waste materials found at WDI were deposited in the concrete-lined reservoir and its surrounding unlined sumps during facility operations. The constituents of these waste materials include metals, volatile organics, semivolatile organics, pesticides, PCB's, and TPH, in varying concentrations. Some are listed as hazardous according to the Resource Conservation and Recovery Act (RCRA) and Title 22 of the California Code of Regulations (CCR).

The samples generated from the soil borings were analyzed for 24 different metals (per Title 22 of the CCR). All of the metals were present in on-site soils to varying extents, but arsenic, baryllium, thallium, and lead were found at significant levels.

According to soil sampling results, there were 26 volatile organic compounds present in on-site soils, but only six compounds (toluene, methylene chloride, acetone, 2-butanone, ethylbenzene and xylene) were found in more than 10% of the samples. Of these, methylene chloride and acetone are common laboratory contaminants. The detectable volatile organics were obtained mainly from samples from depths of zero to 35 feet. However, elevated concentrations were found in some cases to depths of 60 feet.

Forty-four semivolatile organic compounds were detected in on-site soils. Of these contaminants, the concentrations of benzo(a)pyrene, 2-chlorophenol, naphthalene, 2-methylnaphthalene, 4-nitrophenol, phenanthrene, chrysene, 1,4-dichlorobenzene and fluorene are of concern because they are consistently present at 35 feet below ground surface, and could become a source of groundwater contamination. Naphthalene, 2-methylnaphthalene, fluoranthene, benzo(a)anthracene, anthracene, pyrene, phenanthrene, and pentachlorophenol are consistently present on the ground surface.

Table 1-7
Background Concentrations of Metals in Soils at WDI
(taken at St. Paul's High School/Fedco)

METAL	CONCENTRATION RANGE (ppm)	METAL	CONCENTRATION RANGE (ppm)
Aluminum, Al	3450 - 10,300	Magnesium, Mg	1660.0 - 3220.00
Antimony, Sb	2.70 - 3.00	Manganese, Mn	88.80 - 263.00
Arsenic, As	1.68 - 2.31	Mercury, Hg	0.018 - 0.137
Barium, Ba	37.50 - 71.10	Molybdenum, Mo	0.194 - 0.268
Beryllium, Be	0.196 - 0.278	Nickel, Ni	4.05 - 9.23
Cadmium, Cd	0.255 - 0.363	Potassium, K	818.00 - 2260.00
Calcium, Ca	1360.0 - 1870.0	Selenium, Se	0.202 - 0.278
Chromium, Cr	5.96 - 12.10	Silver, Ag	0.863 - 0.939
Cobalt, Co	3.00 - 7.17	Sodium, Na	123.00 - 231.00
Copper, Cu	4.95 - 13.80	Thallium, Tl	9.77 - 12.00
Iron, Fe	6130.00 - 13,700.00	Vanadium, V	10.60 - 27.30
Lead, Pb	3.33 - 7.00	Zinc, Zn	22.10 - 38.30

Twelve pesticides and five PCB's were discovered at the WDI site. None of these contaminants are consistently present at depths greater than four feet below ground level. Alpha-chlordane, gamma-chlordane, dieldrin, DDD, DDE and DDT are the only pesticides consistently present on the surface.

1.9.2.2 Chemical Characteristics of Subareas

Reservoir Area

As expected, the reservoir area is the most contaminated area within the WDI site. Metals, volatile organics, semivolatile organics and pesticides/PCB's were found in the soil samples analyzed. Among metals of concern, arsenic, cadmium, copper, lead and mercury were present in concentrations above the STLC. Lead was present in concentrations above the TTLC. The detected volatile organics of concern include 2-butanone, acetone, benzene, ethylbenzene, methylene chloride, toluene and xylene. Fluoranthene, fluorene, naphthalene, phenanthrene, bis(2-ethylhexyl)phthalate and pyrene were the most frequently detected semivolatiles.

Elevated levels of metals, semivolatile organics, and volatile organic compounds were found in the soils within the reservoir during the remedial investigation. The 5-15 feet of fill material covering the waste material in the reservoir were found to be relatively free of contamination. Throughout the reservoir, below the fill and within the waste itself, lead, barium, beryllium, arsenic, cadmium, copper, nickel, mercury, thallium and vanadium were detected. Of the semivolatile and volatile organic compounds identified within the waste, 2-methylnaphthalene, phenanthrene, benzene, ethylbenzene, xylene, and toluene were the most prevalent. The concentrations of contaminants in soil samples collected from below the wall and base of the reservoir were relatively low. Conversely, soil samples taken immediately below the base of the reservoir showed elevated levels of many of the compounds found within the reservoir. This implies that contamination has migrated through the base, but has not continued to migrate through soils.

Subarea 1

Although Subarea 1 (see Figure 1-6) contains large areas of contamination, it is also largely developed. Again, metals, volatile organics, semivolatile organics and pesticide compounds were detected in this area. Metals were detected in most of the samples. Toluene, acetone, methylene chloride and 2-butanone were the most frequently detected volatile organics. Semivolatile organics and pesticides of concern were detected in relatively few samples.

The highest concentrations of metals were found for barium, calcium, iron and magnesium (all present in various oil field drilling muds). Semivolatile organic contamination is present down to a depth of 35 feet. Volatile organic contamination is also present to a depth of 35 feet and includes 2-butanone, methylene chloride and toluene. Many of the contaminants in Subarea 1 are concentrated between the surface and 20 feet below the surface. This includes most of the metals, pesticides and semi-volatile organics.

Subarea 2 (area surrounding reservoir)

Next to the reservoir, Subarea 2 is the most contaminated area of the site. This area contains several unlined disposal areas as well as the reservoir itself. Metals, volatile organics, semi-volatile compounds, and pesticides/PCB's were detected in the soil samples. The most common semivolatiles present were 2-methylnaphthalene, di-n-butylphthalate, naphthalene, pyrene and phenanthrene. The most common volatile organics present are 2-butanone, acetone, ethylbenzene, methylene chloride, toluene and xylene. Volatile and semi-volatile organic compound concentrations were higher in this area than any other part of the site. Pesticides and PCBs, however, do not appear to present a problem in this area.

The RI report indicated that there were relatively high concentrations of naphthalene, phenanthrene, benzene, 1,1,1-trichloroethane, toluene and xylene in the northwest corner of Subarea 2. The highest concentrations of contaminants in Subarea 2 were detected between the ground surface and the 20-foot depth. Elevated concentrations of 1,4-dichlorobenzene, naphthalene, ethylbenzene, toluene and xylene were found in the southeast corner. Also in this area, constituents of reservoir waste were found in the soil in varying concentrations down to 35 feet below ground surface. The soil in the northeast corner was also found to contain high levels of naphthalene, xylene, phenanthrene, ethylbenzene, and toluene.

Subarea 3

In Subarea 3, metals, volatile organics, and semi-volatile organics were detected in the soil samples. The volatile organics found in the soil samples included 2-butanone, toluene, acetone and chloroform. The most frequently detected semi-volatile organic compound found was di-n-butylphthalate.

Samples taken near the northern edge of Subarea 3 contained three volatiles and two semi-volatiles. No concentrations of these compounds exceeded 0.2 ppm. The metal concentrations near the northern edge were near background levels. Samples taken from the southern edge of Subarea 3 contained volatiles and semi-volatiles. The metals concentrations were similar to background levels.

Subarea 4

Metals, volatile organics, semi-volatile organics and pesticides were found in the soil samples from this area. Metals were found in almost every sample. Volatile organics were found in almost three-quarters of the samples. The volatiles found in the greatest concentrations were toluene (11,000 ppb), ethylbenzene (14,000 ppb) and xylene (42,000 ppb). Benzene is also a concern, since the average concentration found was almost 3500 ppb, with a maximum concentration of 6700 ppb.

Dieldrin, endrin, and heptachlor were the pesticides detected. Naphthalene, 2-methylnaphthalene, fluorene and chrysene were the most prevalent semi-volatiles, and methylene chloride, toluene, ethylbenzene and acetone were the most frequently detected volatiles. The majority of contaminants in this area were found between the surface and 25 feet below ground surface. Semi-volatile and volatile organic contaminants were found mostly in the black sump material and in the sediments directly beneath this material.

Subarea 5

In Subarea 5, metals, volatile organics, semi-volatile organics and one pesticide compound were detected in the area samples. Based on the data obtained during the RI, arsenic, cadmium, chromium, thallium, mercury, cobalt, copper, lead and selenium were detected at depths of 10 and 35 feet. Acetone, 2-butanone, chloroform and toluene were the volatile organics detected, ranging from surface soil to a depth of 30 feet. Di-n-butylphthalate and bis(2-ethylhexyl)phthalate were the semi-volatiles detected at depth. The pesticide compound 4,4'-DDT was detected at the surface.

Subarea 6

Metals, volatile organics, semi-volatile organics and one PCB compound were found in the soil samples of Subarea 6. Among volatile organics, 2-butanone, benzene, ethylbenzene, xylene, acetone, methylene chloride and toluene were detected. Benzene, ethylbenzene and xylene are constituents commonly found in petroleum hydrocarbons. Bis(2-ethylhexyl)phthalate and benzoic acid were the only semi-volatile organic compounds detected in more than one sample.

The concentrations of organic compounds found in this subarea are not as high as in other subareas areas. However, an aerial photo taken in 1937 shows dark standing liquid in the northwest corner of the area.

Subarea 7

Several manufacturing activities and chemical spills have been documented in Subarea 7. The apparent absence of contamination below the 20-foot depth implies that vertical downward migration of contaminants may not have occurred in this area. Metals, volatile organics, and semi-volatile organics were detected in the soil samples. Acetone, ethylbenzene and methylene chloride were the volatile organic compounds found in the samples. Pyrene, benzo(a)pyrene, chrysene, and bis(2-ethylhexyl)phthalate were the semi-volatile organics found, and were only detected in one soil sample. No pesticide or PCB compounds were detected in this area.

Based on the complete chemical data set derived during the RI, the majority of the metals are present in samples from the surface and five-foot depths. The semi-volatile benzo(a)pyrene was present at the five-foot depth with a concentration of 0.96 ppm.

Subarea 8

As with the other subareas, metals, volatile organics, semi-volatile organics and pesticides were found in the soil samples. Volatile organics were detected in the majority of the samples, with the most frequently detected compound being toluene.

Based on the data obtained during the RI, the metals with the highest concentrations were aluminum, calcium and magnesium. Small amounts of naphthalene, phenanthrene and toluene were found in two different borings located in the western portion of the Subarea 8, but no visible signs of waste material were found in these borings.

St. Paul's High School and Fedco

The St. Paul's High School and Fedco areas were used to determine the background concentration of any contaminants. Metals and volatile organics were detected, but no semi-volatiles or pesticides/PCB's were found in these areas. The volatile organics detected in this area, acetone and chloroform, are also common laboratory contaminants. As a result, metals are the only contaminants considered to have a background level.

1.9.3 *Subsurface Gas*

The locations of the 26 subsurface-gas monitoring wells installed during RI field activities are shown in Figure 1-10. The sampling revealed ten gases present in subsurface soils at WDI. These gases were methane, 1,1,1-trichloroethane, 1,2-dibromoethane, benzene, 1,2-dichloroethane, carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, and vinyl chloride. Methane is an important indicator since it is often associated with anaerobic degradation of organic material or waste and could represent an explosion hazard if concentrated inside a confined space, like a building. As would be expected, the largest detection of methane was found in the reservoir area; the surrounding areas had comparatively low amounts. Tetrachloroethene was the most prevalent organic gas present in subsurface media, while trichloroethene had the highest average concentration among the detected organic gases. Vinyl chloride had the highest concentration of any gas found, but was only detected in three wells.

1.9.4 *Groundwater Contamination*

During RI field activities 27 groundwater monitoring wells were installed at various locations throughout the site. Water samples for chemical analysis were collected, water level elevations were measured, and the direction of groundwater flow was determined. There were six wells installed around the perimeter to estimate the groundwater gradient, with the remaining 21 wells installed downgradient of potential sources of contamination. Twenty-one of the 27 monitoring wells were perforated at the uppermost aquifer (55-70 feet below the surface). The remainder were perforated in the deeper aquifer.

Metals were found in background and on-site wells, and in both the shallow and deep wells. Several of these exceed the MCL. The MCL values are used for reference only, since this aquifer is not currently used for drinking water, thus MCLs should not be directly compared to metal concentrations in groundwater. The metals that exceeded their MCL were cadmium, chromium, lead, iron, manganese, and selenium.

Volatile organic compounds were found in groundwater during the RI and the EPA follow-up sampling. Trichloroethene and tetrachloroethene were found in concentrations above the MCL (18 ppb of TCE detected, 11 ppb of PCE, the MCLs are 5 ppb for both). TCE was found in only one well, while PCE was detected in two.

Four semi-volatile organic compounds were detected in WDI groundwater in trace concentrations. Pesticides and PCB compounds were not detected in any groundwater samples during the remedial investigation.

1.9.5 *Summary of Site Contamination*

Surface soil contamination is minimal at WDI. Analyses of samples collected during the RI indicated the presence of three pesticides/PCB's (4,4'-DDT, Aroclor-1260 and 4,4'-DDD) above TTLC's, no metals in concentrations above TTLC's, and 13 volatiles and semivolatiles. The concentrations of volatiles and semivolatiles found were relatively low and ranged from a few ppb to 88 ppm. Only one semivolatile was found above 88 ppm (its level was 830 ppm).

The reservoir is the area of highest contamination, containing various drilling sludges and industrial and petroleum based wastes. Soil samples taken during the RI have indicated that the concrete reservoir is still acting as a barrier to contaminant migration at this time. Metals, volatiles and semivolatiles were found throughout the site in the areas where the sludges and other wastes were disposed.

Subsurface gases exist within the soil matrix at WDI; however, the concentrations found are low. Most are below Threshold Limit Values and Biological Exposure Indices. Concentrations of these gases are even lower at the surface and negligible outside the WDI site. Methane is the most prevalent subsurface gas at WDI. The highest concentrations of methane were found inside the concrete reservoir. However, methane is a simple asphyxiant and does not pose a danger unless explosive concentrations are reached. Methane may act as a carrier, enabling gases to migrate to the surface that may otherwise remain deep in the soil, but more sampling will be required to detemine if this transport phenomenon is occurring.

Ambient air in the vicinity of the site is at background concentrations and was at background concentrations during RI field activities; therefore, there do not appear to be air contamination problems to which the site contributes.

Groundwater analyses have indicated metal contaminants in groundwater above background concentrations. Manganese was found in a concentration above background concentrations in approximately 25% of the groundwater samples taken, and is present in most of the on-site wells. Selenium was also detected in the majority of the wells sampled, with background levels exceeding the California MCL of 10 ppb. On-site, selenium concentrations exceeded the MCL and were similar to background levels (20-80 ppb). Iron was also found to exceed the MCL in both on-site and background wells. Trichloroethene and tetrachloroethene were also found in groundwater at WDI. Groundwater contamination will be addressed further in a separate document.

1.10 Regulatory Involvement

Regulatory involvement began in approximately 1949, when an application was filed with the County of Los Angeles Regional Planning Commission to operate a dump at the WDI site. From that point until approximately 1982, the primary agencies involved with the site were the above-mentioned, plus the City of Santa Fe Springs Redevelopment Agency and the City of Los Angeles, Department of the County Engineer. During that period, numerous complaints were made by the surrounding community and a group known as "Citizens Against the Dump" was formed. Newspaper articles about the site appeared during the 1950's due to repeated complaints of odors emanating from the site, and the presence of children in and around the site (children reportedly used to float out on rafts to the middle of the reservoir). Regulatory action during this time period consisted of a series of warnings and a $100 fine.

In December 1984, DHS evaluated the site under its "Abandoned Site Project". DHS performed a Hazard Ranking System analysis and placed the site on the state "Bond Expenditure List" due to the potential threat of contamination to groundwater. EPA then performed a Site Assessment, and proposed that the site be placed on the NPL in May 1986. In July 1987, the site was finalized on the NPL. An RI was initiated in 1987 and completed in late 1989.

1.11 Potentially Responsible Party (PRP) Information

Figure 1-3 provides a delineation of parcel ownership for this site. General Notice letters were sent to 28 parties, including current property owners and companies identified as generators that disposed of waste materials at WDI.

1.12 Endangerment Assessment Summary

EPA guidance for conducting quantitative risk assessments directs that concentrations of chemicals at exposure points be compared to ARARs. If regulatory levels are not available for all chemicals in the media, then a quantitative risk assessment will be performed. The information on risk was taken from the Final Endangerment Assessment of November 1989, unless otherwise stated.

To estimate potential risk threats posed towards human health under the current and future use scenarios, the estimated chronic daily intake of each chemical for each pathway was compared to critical toxicity values developed by EPA. Reference doses were used as indicators of non-carcinogenic toxicity, and cancer potency factors were used to evaluate carcinogenic risk.

Under current site conditions, exposure pathways consist of direct contact to contaminated surface soils and inhalation of airborne particulates and volatiles by students and nearby residents. Assumptions on exposure and frequency of exposure are listed in Tables 1-8 and 1-9. The average risks are based on the geometric mean of the contaminant concentration for the site and a typical exposure scenario. The maximum risks are based on the highest concentrations observed at the site for each contaminant combined into one "composite sample" to represent the source of contamination and the maximum plausible exposure scenario, except for the air inhalation pathway which was calculated based on the geometric mean of all samples. The conclusions of the Endangerment Assessment are summarized in Table 1-10.

Exposure of trespassers to contaminated surface soils resulted in average potential carcinogenic risks of 5×10^{-7} under average conditions and 3×10^{-5} under plausible maximum conditions. Non-carcinogenic risk is greater than one only under the maximum plausibe case for trespassers (in this case, the value is approximately 3). All other non-carcinogenic risks are considered small under current use scenarios.

Exposure to airborne dust was predicted by modeling dispersion of the surface soil to the air. Inhalation of airborne particulates by residents living 0.1 kilometers from the site could result in 3×10^{-6} and 8×10^{-6} potential upperbound excess lifetime cancer risks for the average and plausible maximum cases, respectively. Potential carcinogenic risks are $5x10^{-7}$ for the average case and $2x10^{-6}$ for the plausible maximum case for residents living 0.5 kilometers from the site. Under average conditions, residents living 1 kilometer from the site could experience a potential upperbound carcinogenic risk of $2x10^{-7}$ and under plausible maximum conditions, an $8x10^{-7}$ potential upperbound carcinogenic risk.

Residents living near WDI could also be exposed to volatile organic compounds released from the site. Inhalation of these volatiles organic compound by residents living 0.1 kilometer from the site could result in $3x10^{-7}$ and $5x10^{-6}$ potential upperbound excess lifetime cancer risks for average and plausible maximum cases, respectively.

Students attending the high school adjacent to the site could inhale airborne particulates or volatile organic compounds released from the site. The potential upperbound carcinogenic risks from inhalation of airborne particulates are $2x10^{-7}$ for the average case and $4x10^{-7}$ for the plausible maximum case. The average and plausible maximum potential upperbound carcinogenic risk from inhalation of volatile organic chemicals are $3x10^{-8}$ and $3x10^{-7}$, respectively.

If the WDI site were developed for residential purposes, residents could be exposed to contaminants present in the surface soils. Risks for two age groups were quantified, (1) adults, and (2) young children aged 1 to 6 years, The potential upperbound excess cancer risks for adults are $3x10^{-6}$ under average exposure conditions and $7x10^{-4}$ under plausible maximum exposure conditions. For young children, the potential upperbound excess cancer risk was estimated to be $2x10^{-5}$ under average conditions and $3x10^{-3}$ under plausible maximum conditions. The non-carcinogenic risks are considerably under maximum plausible conditions with Hazard Index of 10 for adults, and 500 for children. The Hazard Index is also greater than one for average conditions for children, based on a future residential scenario.

The groundwater directly beneath the WDI site could potentially be used as a drinking water source. Exposure to individuals ingesting this water and using it for residential purposes was evaluated under the future risk scenario. Under average exposure conditions, the potential upperbound excess cancer risk is $4x10^{-5}$, while under plausible maximum conditions, the potential upperbound excess cancer risk is $3x10^{-4}$. The hazard indices for groundwater exposure to non-carcinogenic contaminants exceeded one for both adults and children for the maximum plausible case (2 and 8 respectively), but under average exposure conditions, the hazard index for children was two, while adults it was less than one.

The volatile organic chemicals of potential concern present in soils could migrate vertically and enter homes through the foundation if the site were developed for residential purposes. Exposure to on-site residents to indoor air could result in potential upperbound excess cancer risk of $6x10^{-5}$ and $6x10^{-4}$ under average and plausible maximum exposure conditions, respectively. Non-carcinogenic risks all had hazard indices less than one.

1.12.1 *Preliminary Remediation Goals (PRGs)*

As an added assessment of risk posed by WDI, site contamination was compared to health-based soil contamination values called Preliminary Remediation Goals (PRGs). These risk-based values combine updated EPA toxicity values with health-protective exposure assumptions to estimate contaminant levels in environmental media which correspond to a lifetime cancer risk of 10^{-6} risk and/or a hazard index of 1 for non-cancer concerns. For this study, the PRGs for residential soil were used to estimate maximum and average risk at the site. The arithmetic mean was used to calculate the average risk. Table 1-11 lists the risks associated with the chemicals of concern identified in the Endangerment Assessment, and their contribution to the overall excess cancer risk for the site. Table 1-12 shows the non-cancer risks posed by the non-carcinogenic compounds found at WDI. Table 1-13 shows the risks for lead, which is listed separately since the PRG value is not directly comparable to either a excess cancer risk or a hazard index value.

The PRG values are considered conservative, since the endpoint for the toxic effects for a contaminant is considered the entire organism, in this case a human being. In reality, different contaminants target or affect different organs of an organism. (The PRG value is the lowest contaminant level that causes a toxic effect, if different levels target different organs.) The overall risk to the organism would then be addressed by looking at the risk posed to each organ separately; however, assuming the entire organism is the target for each contaminant, the cumulative effect of the contaminants is the sum of those risks posed by each contaminant, regardless of the target organ.

From the PRG tables, the excess cancer risk from the maximum contaminant levels in soils at this site at shallow depths (less than 5 feet), where one would most likely expect direct contact, is 1.1×10^{-4}. The maximum excess cancer risk when all soil boring depths are considered is 6.2×10^{-4}. The average risks for shallow soils is 2.1×10^{-5}, and 8.3×10^{-5} for all soils.

For non-cancer contaminants, the Hazard Quotient (HQ) is used to compare the level of contamination found at the site with the PRG contaminant level that corresponds to a hazard index of 1. The HQs are added to determine the overall hazard index for the non-carcinogenic contaminants at the site. From Table 1-12, arsenic and thallium are shown to be the largest contributors to the hazard index for all soils at all depths, although the risk posed by DDT is considerable when all depths are considered. The hazard index for shallow soils using maximum contaminant levels is 11.8. The hazard index for the average contaminant level in shallow soils is 3.6. When all soils are considered, the maximum hazard index is 31.6, while the average contaminant level hazard index is 4.3.

Table 1-8
Assumptions Used to Evaluate the Inhalation Pathway at WDI

PARAMETER	AVERAGE CASE	PLAUSIBLE MAXIMUM CASE
Off-site Adult Residents		
Frequency of Exposure	330 days/year	330 days/year
Duration of Exposure	24 hours/day	24 hours/day
Exposure Period	9 years	30 years
Age during Exposure Period	Adult	Adult
Average Weight during Exposure Period	70 kg	70 kg
Inhalation Rate	20 m^3/day	20 m^3/day
Students		
Frequency of Exposure	180 days/year	180 days/year
Duration of Exposure	8 hours/ day	8 hours/day
Exposure Period	4 years	6 years
Age during Exposure Period	14-17 years	13-18 years
Average Weight during Exposure Period	60 kg	60 kg
Inhalation Rate	20 m^3/day	20 m^3/ day
General		
Lifetime	75 years	75 years

Source: Final Endangerment Assessment, November 1989

Table 1-9
Assumptions Used to Evaluate the Direct Contact Pathway at WDI

PARAMETER	AVERAGE CASE	PLAUSIBLE MAXIMUM CASE
Off-site Adult Residents		
Frequency of Exposure	1 event/week	5 events/week
Age during Exposure Period	14-17 years	13-18 years
Duration of Exposure	4 years	6 years
Average Weight during Exposure Period	60 kg	60 kg
Area of Exposed Skin	1400 cm^2	1980 cm^2
Rate of Incidental Soil Ingestion	100 mg	100 mg
Lifetime	75 years	75 years
Soil Contact Rate	1.45 $mg/cm^2/day$	2.77 $mg/cm^2/day$
Oral Absorption Factors		
Pesticides, PCBs, PAHs	0.15	0.50
Arsenic	0.80	0.80
All Other Chemicals	1.00	1.00
Dermal Absorption Factors		
Volatile Organic Chemicals	0.10	0.10
Non-carcinogenic PAHs	0.03	0.05
Carcinogenic PAHs	0.009	0.02
PCBs	0.07	0.07
Phenolic Compounds	0.20	0.20
DDT	0.02	0.02

Source: Final Endangerment Assessment, November 1989

Table 1-10
Summary of Potential Health Risks

	Total Upperbound Lifetime Excess Cancer Risks		Non-carcinogenic Hazard Index (CDI:RFD)	
	Average Case	Plausible Maximum Case	Average Case	Plausible Maximum Case
CURRENT USE:				
Exposure of trespassers to surface soils	5×10^{-7}	3×10^{-5}	< 1	> 1
Exposure of off-site residents to airborne particulates				
- 0.1 km	3×10^{-6}	8×10^{-6}	< 1	< 1
- 0.5 km	5×10^{-8}	1×10^{-6}	< 1	< 1
- 1.0 km	2×10^{-7}	8×10^{-7}	< 1	< 1
Exposure of students to airborne particulates	2×10^{-7}	4×10^{-7}	< 1	< 1
Exposure of off-site residents to airborne volatile chemicals				
- 0.1 km	3×10^{-7}	5×10^{-6}	< 1	< 1
- 0.5 km	5×10^{-8}	1×10^{-6}	< 1	< 1
- 1.0 km	2×10^{-8}	5×10^{-7}	< 1	< 1
Exposure of students to airborne volatile chemicals	3×10^{-8}	3×10^{-7}	< 1	< 1
FUTURE USE:				
Exposure of on-site residents to surface soils				
- Adults	9×10^{-6}	8×10^{-4}	< 1	> 1
- Children (1-6 years)	4×10^{-5}	3×10^{-3}	> 1	> 1
Exposure of on-site residents to groundwater				
- Adults	4×10^{-5}	3×10^{-4}	< 1	> 1
- Children			> 1	> 1
Exposure of on-site residents to volatiles in indoor air				
- Adults	6×10^{-5}	6×10^{-4}	< 1	< 1
- Children			< 1	< 1

Source: Final Endangerment Assessment, November 1989

TABLE 1-11, MAXIMUM AND AVERAGE CARCINOGENIC RISK FOR WDI

All conc. levels are in mg/kg. Risk=Conc./PRG Means are Arithmetic Means	PRG	SHALLOW SOIL (0 - 5 FT) MAX CONC.	SHALLOW SOIL (0 - 5 FT) MAX RISK	SHALLOW SOIL (0 - 5 FT) MEAN CONC.	SHALLOW SOIL (0 - 5 FT) AVG RISK	TOTAL SOIL CONCENTRATIONS MAX CONC.	TOTAL SOIL CONCENTRATIONS MAX RISK	TOTAL SOIL CONCENTRATIONS MEAN CONC.	TOTAL SOIL CONCENTRATIONS AVG RISK
INORGANIC									
Arsenic	9.7E-01	8.5E+01	8.8E-05	1.1E+01	1.1E-05	3.4E+02	3.5E-04	1.2E+01	1.2E-05
ORGANIC									
Aldrin	1.0E-01	2.3E-02	2.3E-07	2.3E-02	2.3E-07	2.3E-02	2.3E-07	2.3E-02	2.3E-07
Benzene	2.7E+00	1.4E+00	5.2E-07	6.9E-01	2.6E-07	1.9E+01	7.0E-06	2.3E+00	8.7E-07
BHC (Lindane)	1.5E+00	--	--	--	--	1.5E-02	1.0E-08	1.1E-02	7.5E-09
Carbon Tetrachloride	9.2E-01	--	--	--	--	2.0E-03	2.2E-09	2.0E-03	2.2E-09
Chlordane	1.3E+00	8.6E-01	6.6E-07	2.2E-01	1.7E-07	8.6E-01	6.6E-07	2.2E-01	1.7E-07
Chloroform	9.6E-01	5.0E-03	5.2E-09	3.0E-03	3.1E-09	5.0E-03	5.2E-09	1.9E-03	2.0E-09
DDD	7.1E+00	3.3E+00	4.6E-07	6.5E-01	9.2E-08	6.2E+00	8.7E-07	3.8E+00	5.4E-07
DDE	5.0E+00	5.3E-01	1.1E-07	2.8E-01	5.6E-08	3.0E+01	6.0E-06	1.7E+00	3.3E-07
DDT	5.0E+00	7.4E-01	1.5E-07	4.0E-01	8.1E-08	2.6E+02	5.2E-05	1.5E+01	2.9E-06
Dieldrin	1.1E-01	2.8E-01	2.5E-06	1.1E-01	1.0E-06	2.8E-01	2.5E-06	1.1E-01	1.0E-06
1,4 Dichlorobenzene	1.7E+01	8.0E-01	4.7E-08	8.0E-01	4.7E-08	2.4E+00	1.4E-07	1.1E+00	6.3E-08
Heptachlor	3.8E-01	--	--	--	--	8.7E-02	2.3E-07	4.5E-02	1.2E-07
Heptachlor Epoxide	1.9E-01	4.6E-02	2.4E-07	2.4E-02	1.3E-07	4.6E-02	2.4E-07	2.4E-02	1.3E-07
Methylene Chloride	2.2E+01	1.2E+00	5.5E-08	1.7E-01	7.9E-09	2.4E+00	1.1E-07	1.3E-01	6.0E-09
PAHs-carcinogenic									
Benzo(a)anthracene	2.3E+00	3.8E-01	1.7E-07	1.7E-01	7.5E-08	1.5E+00	6.5E-07	4.5E-01	2.0E-07
Benzo(a)pyrene	2.3E-01	9.6E-01	4.2E-06	4.0E-01	1.7E-06	1.5E+00	6.5E-06	3.9E-01	1.7E-06
Benzo(b)fluoranthene	2.3E+00	3.5E-01	1.5E-07	2.1E-01	9.0E-08	2.2E+00	9.6E-07	4.7E-01	2.0E-07
Benzo(k)fluoranthene	2.3E+00	3.4E-01	1.5E-07	1.3E-01	5.7E-08	4.1E-01	1.8E-07	2.0E-01	8.8E-08
Chrysene	2.3E+02	6.2E-01	2.7E-09	2.8E-01	1.2E-09	8.0E+00	3.5E-08	8.5E-01	3.7E-09
Indeno(1,2,3-c,d)pyrene	2.3E+00	7.4E-02	3.2E-08	7.4E-02	3.2E-08	4.5E-01	2.0E-07	2.0E-01	8.8E-08
PCBs	2.2E-01	3.2E+00	1.5E-05	1.2E+00	5.3E-06	3.2E+00	1.5E-05	6.4E-01	2.9E-06
Pentachlorophenol	1.4E+01	2.9E-01	2.1E-08	2.1E-01	1.5E-08	3.4E-01	2.4E-08	2.6E-01	1.8E-08
Tetrachloroethylene	2.1E+01	5.0E-03	2.4E-10	3.5E-03	1.7E-10	4.3E+01	2.0E-06	6.3E+00	3.0E-07
Trichloroethylene	1.4E+01								
Vinyl Chloride	9.7E-03	--	--	--	--	1.7E+00	1.8E-04	5.7E-01	5.9E-05
SUM			1.1E-04		2.1E-05		6.2E-04		8.3E-05

TABLE 1-12, MAXIMUM AND AVERAGE NON-CARCINOGENIC RISK FOR WDI									
All concentration levels are in mg/kg. Hazard Quotient (HQ) = Max Conc./PRG Means are Arithmetic Means		SHALLOW SOIL (O - 5 FT)				TOTAL SOIL CONCENTRATIONS			
	PRG	MAX CONC.	MAX HQ	MEAN CONC.	AVG HQ	MAX CONC.	MAX HQ	MEAN CONC.	AVG HQ
INORGANICS									
Anitimony	3.1E+01	2.5E+01	8.1E-01	6.2E+00	2.0E-01	2.5E+01	8.1E-01	5.8E+00	1.9E-01
Arsenic	2.3E+01	8.5E+01	3.7E+00	1.1E+01	4.8E-01	3.4E+02	1.5E+01	1.2E+01	5.1E-01
Cadmium	3.9E+01	1.8E+01	4.7E-01	1.7E+00	4.3E-02	1.8E+01	4.7E-01	1.4E+00	3.6E-02
Chromium	3.9E+02	1.5E+02	3.8E-01	2.9E+01	7.4E-02	1.5E+02	3.8E-01	2.9E+01	7.4E-02
Copper	2.9E+03	7.2E+02	2.5E-01	5.2E+01	1.8E-02	7.2E+02	2.5E-01	4.3E+01	1.5E-02
Manganese	7.8E+03	2.1E+03	2.7E-01	4.2E+02	5.4E-02	2.3E+03	2.9E-01	4.5E+02	5.8E-02
Mercury	2.3E+01	1.1E+01	4.7E-01	4.3E-01	1.9E-02	1.1E+01	4.7E-01	2.9E-01	1.3E-02
Selenium	3.9E+01	1.2E+00	3.1E-02	5.2E-01	1.3E-02	1.2E+00	3.1E-02	5.0E-01	1.3E-02
Thallium	5.5E+00	2.8E+01	5.0E+00	1.4E+01	2.6E+00	3.9E+01	7.1E+00	1.6E+01	2.9E+00
Zinc	2.3E+04	7.8E+02	3.4E-02	1.3E+02	5.5E-03	--	--	--	--
ORGANICS									
Aldrin	2.3E+00	2.3E-02	1.0E-02	2.3E-02	1.0E-02	2.3E-02	1.0E-02	2.3E-02	1.0E-02
gamma-BHC	2.3E+01	--	--	--	--	1.5E-02	6.5E-04	1.1E-02	4.9E-04
Benzoic Acid	3.1E+05	1.3E+00	4.2E-06	3.4E-01	1.1E-06	1.3E+00	4.2E-06	2.4E-01	7.7E-07
Carbon Tetrachloride	1.3E+01	--	--	--	--	2.0E-03	1.5E-04	2.0E-03	1.5E-04
Chlordane	4.7E+00	8.6E-01	1.8E-01	2.2E-01	4.8E-02	8.6E-01	1.8E-01	2.2E-01	4.8E-02
Chloroform	3.2E+02	5.0E-03	1.6E-05	3.0E-03	9.4E-06	5.0E-03	1.6E-05	1.9E-03	5.9E-06
DDT	3.9E+01	7.4E-01	1.9E-02	4.0E-01	1.0E-02	2.6E+02	6.7E+00	1.5E+01	3.7E-01
1,4 Dichlorobenzene	4.0E+04	8.0E-01	2.0E-05	8.0E-01	2.0E-05	2.4E+00	6.0E-05	1.1E+00	2.7E-05
Dieldrin	3.9E+00	2.8E-01	7.2E-02	1.1E-01	2.9E-02	2.8E-01	7.2E-02	1.1E-01	2.9E-02
Ethylbenzene	1.5E+04	1.1E+01	7.3E-04	1.8E+00	1.2E-04	7.3E+01	4.9E-03	5.2E+00	3.5E-04
Heptachlor	3.9E+01	--	--	--	--	8.7E-02	2.2E-03	4.5E-02	1.1E-03
Heptachlor Epoxide	1.0E+00	4.6E-02	4.6E-02	2.4E-02	2.4E-02	4.6E-02	4.6E-02	2.4E-02	2.4E-02
Methylene Chloride	1.3E+04	1.2E+00	9.2E-05	1.7E-01	1.3E-05	2.4E+00	1.8E-04	1.3E-01	1.0E-05

TABLE 1-12, MAXIMUM AND AVERAGE NON-CARCINOGENIC RISK FOR WDI									
All concentration levels are in mg/kg. Hazard Quotient (HQ) = Max Conc./PRG Means are Arithmetic Means		SHALLOW SOIL (O - 5 FT)				TOTAL SOIL CONCENTRATIONS			
	PRG	MAX CONC.	MAX HQ	MEAN CONC.	AVG HQ	MAX CONC.	MAX HQ	MEAN CONC.	AVG HQ
PAHs-noncarcinogenic									
Acenaphthalene	3.0E+04	7.4E-01	2.5E-05	5.6E-01	1.9E-05	2.3E+00	7.7E-05	6.4E-01	2.1E-05
Anthracene	3.7E+05	2.6E-01	7.0E-07	1.6E-01	4.2E-07	1.6E+01	4.3E-05	2.0E+00	5.3E-06
Fluoranthene	3.1E+03	7.7E-01	2.5E-04	2.9E-01	9.4E-05	1.5E+00	4.8E-04	3.7E-01	1.2E-04
Fluorene	4.3E+04	2.0E+00	4.7E-05	1.1E+00	2.7E-05	1.8E+01	4.2E-04	2.2E+00	5.0E-05
Naphthalene	1.2E+03	9.2E+00	7.7E-03	2.0E+00	1.7E-03	5.2E+01	4.3E-02	7.0E+00	5.8E-03
Pyrene	2.3E+03	1.4E+00	6.1E-04	4.1E-01	1.8E-04	4.3E+00	1.9E-03	5.9E-01	2.6E-04
Pentachlorophenol	2.3E+03	2.9E-01	1.3E-04	2.1E-01	9.3E-05	3.4E-01	1.5E-04	2.6E-01	1.1E-04
Toluene	7.5E+03	1.2E+01	1.6E-03	8.5E-01	1.1E-04	1.2E+02	1.6E-02	2.1E+00	2.8E-04
1,1,1 Trichloroethane	2.0E+04	1.8E+00	9.0E-05	1.5E+00	7.5E-05	1.8E+00	9.0E-05	5.5E-01	2.8E-05
Trichloroethylene	2.4E+02	–	–	–	–	5.0E+00	2.1E-02	9.4E-01	3.9E-03
Xylenes	4.9E+04	6.2E+01	1.3E-03	6.7E+00	1.4E-04	4.1E+02	8.4E-03	7.6E+01	1.6E-03
HAZARD INDEX			11.8		3.6		31.6		4.3

The Hazard Index is the sum of the individual Hazard Quotients (HQ).

TABLE 1-13. MAXIMUM AND AVERAGE NON-CARCINOGENIC RISK DUE TO LEAD FOR WDI									
All levels in mg/kg Means are Arithmetic Means		SHALLOW SOIL (0 - 5 FT)				TOTAL SOIL CONCENTRATIONS			
	PRG	MAX CONC.	MAX RISK	MEAN CONC.	AVG RISK	MAX CONC.	MAX RISK	MEAN CONC.	AVG RISK
LEAD	500	2800	5.6	160	0.32	2800	5.6	120	0.24

*Based on current EPA guidance, a reference dose (RfD) approach for estimating a PRG for lead is not considered appropriate. Therefore, lead is not considered in the cumulative Hazard Index (HI). The comparison of soil lead concentrations to the lead PRG is considered separately in the analysis.

2.0 IDENTIFICATION OF REMEDIAL RESPONSE OBJECTIVES

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, mandates protective and cost-effective remedial actions. Remedial actions, as defined by 40 CFR Part 300.68(a)(1) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), are those responses to releases that are consistent with a permanent remedy to protect against and minimize the release of hazardous substances, pollutants, or contaminants so that they do not migrate and cause substantial danger to present and future public health and welfare or the environment.

In formulating a remedy, CERCLA requires EPA to place emphasis on risk reduction through destruction or treatment of hazardous waste. Section 121 requires that EPA select a remedy that protects human health and the environment, is cost-effective, utilizes permanent solutions, and tries alternative treatment technologies to the maximum extent practicable. Furthermore, Section 121 requires that upon completion, remedies attain applicable or relevant and appropriate Federal and State requirements (ARARs), unless specified waivers are invoked.

Section 300.68 of the NCP, in conjunction with the EPA guidance document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA," sets forth the remedial alternative development and remedy selection process.

The nature and extent of contamination at the WDI Site is documented in the Remedial Investigation Report and summarized in Section 1.9 of this Feasibility Study. A discussion of the identification of general response objectives and cleanup levels for site remediation is detailed in this chapter.

2.1 General Response Objectives

EPA guidance recommends development of cleanup goals for the target excess lifetime cancer risk range of 10^{-4} to 10^{-6}, or a hazard index less than one. The conclusions of the baseline Endangerment Assessment are summarized in Section 1.12 and Table 1-10 of this FS, and are further discussed below.

2.1.1 *Current Site Conditions*

As presented in Section 1.12 and Table 1-10, there are low risks from soils and subsurface gases based on existing site conditions. All the carcinogenic risks for the evaluated scenarios are within, or only slight above, levels EPA considers acceptable. For non-carcinogenic risk, only direct exposure of trespassers to surface soil poses slight risk with a hazard index greater than one. The major contributors are arsenic, lead, chromium, cadmium, DDT and thallium. The PRG evaluation determined similar risks, as can be seen in Tables 1-11 and 1-12.

2.1.2 *Future Site Conditions*

Under the future-use scenario, it was assumed that the site would be developed for residential use. This provides a maximum exposure scenario, though the site is zoned for light industrial use. The carcinogenic risks for the three routes of exposure examined (direct contact, ingestion of shallow groundwater and inhalation of volatile organics) exceed recommended risk levels. The major contaminants of concern are arsenic, DDT, cPAHs (carcinogenic polynuclear aromatic hydrocarbons), and PCBs in surface and subsurface soil; arsenic and volatiles in groundwater; and benzene, 1-2-dibromoethane, 1-2-dichloroethane and vinyl chloride in subsurface gases.

The non-carcinogenic hazard indices exceed one for direct contact with contaminated soils and ingestion of groundwater. The major contributors to the indices are arsenic, lead, thallium, zinc and DDT in surface and subsurface soil, and arsenic, lead and manganese in groundwater.

2.1.3 *Remedial Response Objectives*

The above discussion indicates that the WDI site poses a risk to human health under future use scenarios via contamination in soil, subsurface gases, and potentially groundwater. The remedial objectives developed would be targeted to individual media.

Soil: The surface and subsurface soils are contaminated by organic and inorganic contaminants. The major routes of exposure are direct contact and inhalation of dust. The major remedial objectives are therefore to:

- Provide protection of the environment and human health against risks associated with exposure to contaminated soil and
- Comply with ARARs.

Subsurface Gases: The presence of volatile organics such as 1-2-dibromoethane, trichloroethene (TCE), and vinyl chloride, which were detected in subsurface gas samples, may represent potential health risks to residents on-site breathing indoor air, where these gases may accumulate. However, these gases were not detected in the ambient samples, nor in the outlying vapor wells. These results suggest that migration of gases is not occurring to a significant extent. The remedial objective for the subsurface gases is to provide protection of human health from potential risks associated with exposure to subsurface gases and preventing gas migration.

Groundwater: Remedial objectives for groundwater will be addressed separately following further investigation.

2.2 Remedial Action Objectives for Soils

To ensure protection to human health under current and future site conditions, it is necessary to establish soil action levels. As a first step, ARARs were reviewed, if available, for chemicals of concern, and the most restrictive ARAR selected as an action level. Since there are no chemical-specific ARARs for soil contamination, a soil action level is based on the greater of either the PRG (the chemical concentration which results in a 10^{-6} risk for carcinogens or hazard index greater than 1 for non-carcinogens), or a level that exceeds background concentrations. (Samples are considered to exceed background concentrations if they are five times greater than the background concentration for the contaminant. See Appendix 1 for tabulations of soil borings outside the reservoir that exceed the PRG, background, and also a 10^{-5} risk level.)

As explained in Section 1.12.1 and shown in Table 1-11, PRGs are media-specific, health-based concentrations for contaminants of concern. The contaminants of concern in soil, as discussed in Sections 2.1.1 and 2.1.2, are arsenic, chromium, cadmium, lead, thallium, DDT, cPAHs and PCBs. (Beryllium was also found throughout the site, and is listed in Appendix 1 for soils borings that exceed PRG levels; it was not considered in the Endangerment Assessment, however.) Table 2-1 presents the PRGs and background levels for these chemicals. Since the PRGs for cPAHs vary by chemical, the most restrictive value (for benzo(a)pyrene) is listed in the table. The PRG listed for thallium is the most restrictive PRG for a thallium compound, thallium oxide. Since these PRGs are health-based and are presented here for the purpose of developing alternatives, some of these concentrations represent levels below background.

2.3 Areal Extent and Volume of Contamination in Soil

To determine the spatial extent of contamination at the WDI site, the Remedial Investigation results were compared to the remedial goals developed in the previous section. Appendix 1 lists the soil borings outside the reservoir area that exceed the PRG and also notes if it exceeds background levels or excess risk levels (10^{-5} for cancer, or a hazard index of 10). There is no general trend indicating that contaminants are confined to one particular area, except that pesticides were detected at high concentrations at the former Toxo Spray Dust, Inc. property. There is also surface contamination sporadically located throughout the site. Figure 2-1 shows soil borings that exceed PRG levels for the subareas outside the reservoir for contaminants other than arsenic, beryllium, and thallium (since these are found in most soil boring locations.) Again, Appendix 1 shows these data.

Table 2-1
Preliminary Remediation Goals (PRGs) and Background Levels for Contaminants of Concern In Soils at WDI

CHEMICAL	PRG (mg/kg)	BACKGROUND (mg/kg)
Arsenic	0.97	1.68 - 2.31
Beryllium	0.41	0.196 - 0.278
Chromium	44	5.96 - 12.10
Cadmium	39	0.255 - 0.363
Lead	500	3.33 - 7.00
Thallium	5.5	9.77 - 12.00
DDT	5	---
cPAHs	0.23	---
PCBs	0.22	---

Borings SB-075 and SB-084 had comparatively high levels of pesticides, which is not surprising since these were located on the Toxo property. Other soil borings located at parcels surrounding these two borings were clean. It appears that this contamination is localized and is probably due to spillage or leakage from tanks or underground piping. (These borings were located adjacent to tanks.) The areal extent of contamination is assumed to be 100' by 50', which encompasses both borings. (The borings were 50 feet apart.) Boring SB-075 was contaminated from 0 to 5 feet. The sample at 10 feet was clean. The contaminated volume surrounding this boring is therefore estimated to be 700 cubic yards (50' x 50' x 7.5'). Boring SB-084 was contaminated at 5 and 10 feet below the surface. The contaminated zone is therefore assumed to extend from 2.5 to 12.5 feet below the surface, and the estimated contaminated volume is calculated to be approximately 900 cubic yards (50' x 50' x 10').

PCBs were detected in three borings at depth, and at SB-079 and SB-103 at the surface. Since samples around these borings did not detect PCBs, it is assumed that the contamination is localized. Refer to the Remedial Investigation Report and Appendix 1 for a detailed list of soil boring data.

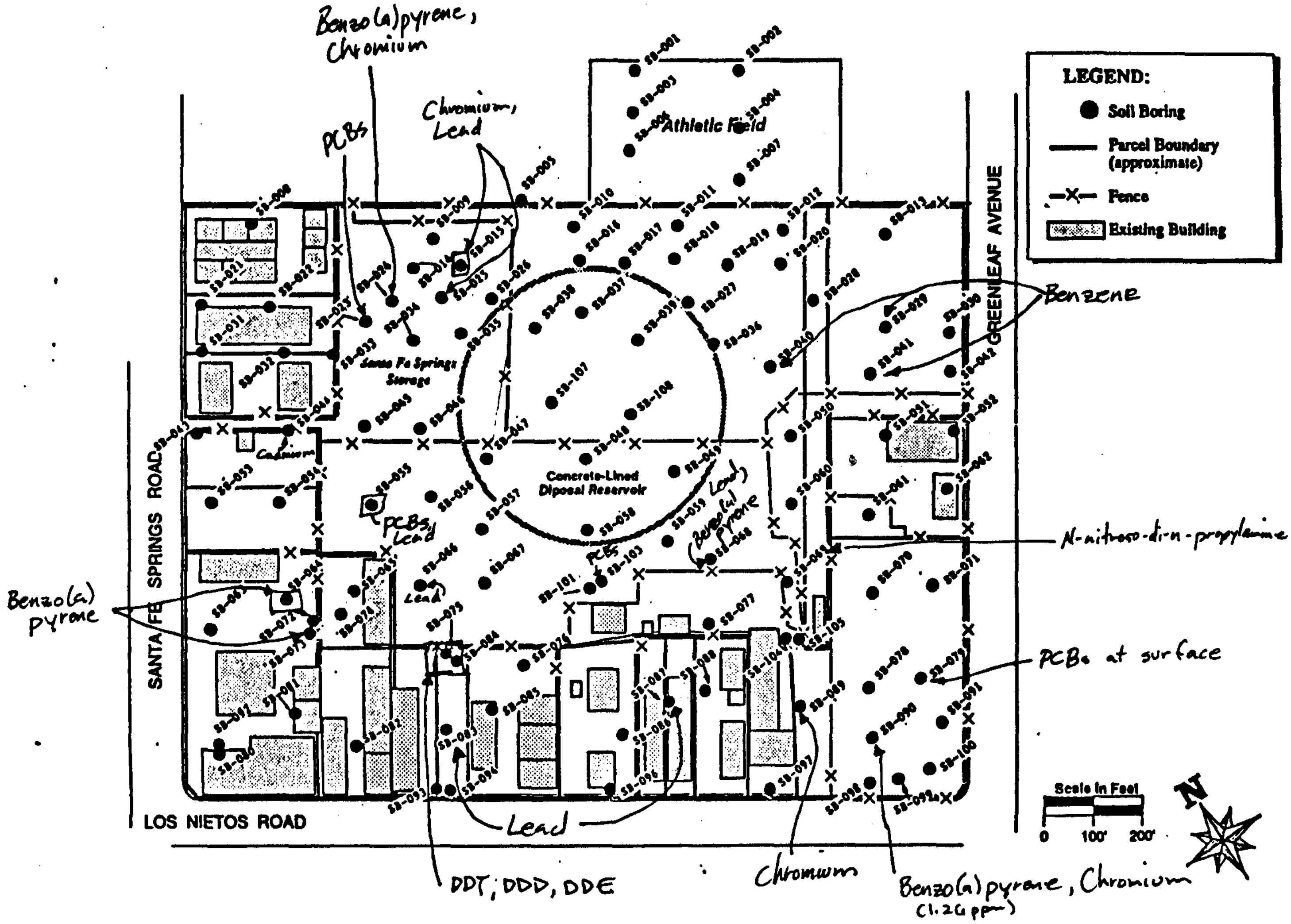


Figure 2-1, Soil Borings Outside Reservoir Exceeding PRGs

Samples with lead concentrations exceeding PRGs occur at various locations in the reservoir area. All contamination is subsurface, at depths of 5 feet and below. Lead was also detected in eight borings outside the reservoir, including two detections at the surface. While not a widespread problem, lead contamination is a concern to be addressed by the remediation goals.

The subsurface contamination by cPAHs within the reservoir and throughout the site occurs at different locations from that of lead. The combined occurrence of lead and cPAH contamination requires that the entire Reservoir Area, plus surrounding parcels be addressed in order to meet the established clean-up goals. The occurence of lead contamination and cPAHs exceeding cleanup criteria outside the reservoir include borings SB-015, SB-017, SB-025, SB-055, SB-066, SB-068, SB-083, and SB-087 for lead, and SB-024, SB-047, SB-064, SB-068, SB-073, and SB-090 for the cPAH benzo-(a)-pyrene. Borings SB-064, SB-073, SB-083 and SB-087 are located in paved areas, so there is little risk from these areas.

2.4 Remediation of Subsurface Gases

Volatile organic compounds were detected in most soil samples taken at the site. The contamination was widespread, in particular at the southern portion of the site, where many existing structures are located. Due to the widespread nature of the subsurface gases, it is not possible to pinpoint a source area. The reservoir, however, had the highest concentration of benzene and vinyl chloride. The highest concentration of TCE was detected at VW22, which was outside the reservoir. (See Figure 1-10 for the locations of Subsurface Gas Monitoring wells.)

As discussed earlier, the migration of subsurface gases was not found to be significant. The gases would only pose a risk to on-site residents living in a confined space, such as a cellar or other structure that is not designed to dissipate gases. However, further study must be done to ensure that gas migration is not occurring; the remedial objective for subsurface gases will be to prevent exposure to existing or migrating gases, either through restriction of site development, or venting and treating the gases.

2.5 Applicable or Relevant and Appropriate Requirements (ARARs)

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), requires that the remedy chosen at a site must attain legally applicable or relevant and appropriate requirements (ARARs) unless the basis for a statutory waiver exists. ARARs are standards, criteria or limits promulgated under Federal or State law. Only those State standards that are more stringent than Federal requirements, timely identified by the State, and consistently applied by the State can be considered ARARs.

Applicable requirements are those standards, requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting laws that specifically address a hazardous substance, remedial action, location, or other circumstance at a CERCLA site. Relevant or appropriate requirements are those standards, requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting laws that, while not applicable to the site, describe a hazardous substance, remedial action, location or other circumstance sufficiently similar to the circumstances at the site that their uses are well suited to the site. In some circumstances, a requirement may be relevant but not appropriate. If a determination is made that a requirement is relevant and appropriate, such a requirement must be met to the same extent as an applicable requirement.

CERCLA requires that all response actions at a CERCLA site comply with the substantive requirements of the ARARs selected for the remedy. Pursuant to CERCLA §121(e), administrative requirements, including permitting requirements, are not ARARs and are not required to be met for the on-site portion of any CERCLA response action. Any action that takes place off-site is subject to the full requirements of Federal, State, and local regulations.

Non-promulgated policy, advisories, or guidance may be considered when developing remediation levels necessary to protect public health. These items are called "To Be Considered" (TBC) criteria. TBCs are not legally binding and do not have the status of potential ARARs; however, in many circumstances, TBCs may be used in determining the necessary level of cleanup for protection of health or the environment.

EPA has developed three categories of ARARs to assist in the identification of ARARs. The three categories are (1) chemical-specific, (2) location-specific, and (3) action-specific ARARs. EPA recognizes that some requirements may not fall neatly into this classification. The categories are described as follows:

- **Chemical-specific:** These ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numeric values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to the ambient environment.

- **Location-specific:** These ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations. Location-specific ARARs relate to the geographical or physical position of the site (e.g., presence of wetlands, endangered species, flood plains, etc.)

- **Action-specific:** Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances.

Section 121(d)(4) of CERCLA provides an exception to the requirement that ARARs be met for remedial action only if one or more of the following conditions exist:

1. The remedial action selected is only part of the total remedial action that will ultimately attain such levels or standards of control when completed;

2. Compliance with the ARAR will result in a greater risk to human health and the environment;

3. Compliance is technically impracticable;

4. The remedial action will attain a standard of performance equivalent to an ARAR through use of another method;

5. The State has not consistently applied the standard requirement, criteria, or limitations to other similar sites within the state; or

6. The ARAR would require too great an expenditure from the Superfund Trust Fund.

2.5.1 *Specific ARARs*

The specific regulations that are applicable or relevant and appropriate for the Waste Disposal, Inc. site are listed below. For a description of the regulations, see Table 2-3 at the end of this chapter. This list is not intended to serve as the final determination of all ARARS for the activities outlined in this Feasibility Study. The identification of ARARs is an iterative process, and the final determination of ARARs will be made by EPA as part of the selection of the remedy, and will take into account public comment.

No location- or chemical-specific ARARs have thus far been identified. The action-specific ARARs identified for WDI are:

Hazardous Waste Control Act (HWCA) (State equivalent of RCRA)

- Monitoring for Interim Status and Permitted Facilities, 22 CCR § 66264.90
- Landfill Closure and Post-closure Care, 22 CCR § 66264.310
- Incineration Regulations
    - 22 CCR § 66264.341 - Waste Analysis
    - 22 CCR § 66264.343 - Performance Standards
    - 22 CCR § 66264.345(d) - Fugitive Emissions
    - 22 CCR § 66264.351 - Closure

California Integrated Waste Management Board Regulations
- 14 CCR Chapter 3, § 17773, Final Cover
- 14 CCR Chapter 3, § 17783-83.15, Gas Monitoring and Control During Closure and Post-closure
- 14 CCR Chapter 3, § 17796, Post-closure Land Use

Porter-Cologne Water Quality Act
- Water Quality Monitoring for Classified Waste Management Units, 23 CCR § 2550

South Coast Air Quality Management District (SCAQMD) Regulations
- Rule 401 - Visible Emissions
- Rule 402 - Nuisance
- Rule 403 - Fugitive Dust
- Rule 404 - Particulate Matter (Concentration)
- Rule 405 - Solid Particulate Matter
- Rule 407 - Liquid and Gaseous Air Contaminants
- Rule 408 - Circumvention
- Rule 409 - Combustion
- Rule 473 - Disposal of Solid and Liquid Wastes
- Rule 1108.1 - Emulsified Asphalt
- Regulation IX - Standards of Performance of New Stationary Sources
- Regulation X - National Emission Standards for Hazardous Air Pollutants
- Regulation XI -
  - Rule 1150 - Excavation of Landfill Site
  - Rule 1150.2 - Control of gaseous emissions from inactive landfills

The following guidance has been identified as TBC:

- EPA/530-SW-89-047, July 1989, "Final Covers on Hazardous Waste Landfills and Surface Impoundments"
- EPA/540/P-91-001, February 1991, "Conducting Remedial Investigations/ Feasibility Studies for CERCLA Municipal Landfill Sites
- Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAPS), Fugitive Emissions Sources

The major action-specific regulations are part of the State Hazardous Waste Control Law (Health and Safety Codes, Division 20, Chapter 6.5), the State equivalent of the Federal Resource Conservation and Recovery Act (RCRA). Although WDI was never a permitted facility under Federal or State hazardous waste laws, and no wastes were treated, stored, or dipsosed of at the site after the effective date of RCRA (November 19, 1980) some of the hazardous waste regulations are considered either applicable or relevant and appropriate in relation to proposed alternatives in this FS.

RCRA requirements are applicable if the following conditions are met:

(1) the waste is a listed or characteristic waste under RCRA; <u>and</u>
(2) (a) the waste was treated, stored or disposed after the effective date of the RCRA requirements; <u>or</u>
(b) the activity at the CERCLA site constitutes treatment, storage, or disposal as defined by RCRA.

Even where RCRA requirements are not applicable, they may be relevant and appropriate where EPA believes the waste is a RCRA waste or is sufficiently similar to a RCRA waste and particular RCRA requirements are designed to address a problem similar to that being encountered at the CERCLA site.

EPA believes that a number of the hazardous substances present at the WDI site are characteristic hazardous wastes under RCRA. In addition, one of the remedial alternatives--that involving incineration--would be considered to constitute treatment. In the event that remedial alternative were selected, certain of the hazardous waste regulations set forth above would probably be applicable. The other remedial alternatives do not constitute treatment, storage or disposal under RCRA. However, many of the hazardous waste regulations set forth above--particularly those relating to closure--would be relevant and appropriate because they are designed to address a problem similar to that encountered at the site, namely, closing a facility with wastes in place.

Land disposal restriction (LDRs) under RCRA are not ARARs for the WDI site. LDRs are applicable or relevant and appropriate whenever there is placement of soil containing listed waste on the land. However, LDRs are not applicable if contaminations is consolidated in one area of contiguous contamination. The WDI site is considered an area of contiguous contamination, since sampling shows contamination exists throughout the site at varying depths, and that waste was disposed in most areas of the site. Therefore, contaminated soils can be consolidated within the facility without triggering LDRs.

The South Coast Air Quality Management District (SCAQMD) rules and regulations constitute the other major source of action-specific ARARs for WDI. Since some of the alternatives might impact air quality, these rules and regulations may be applicable to actions taken at the site, while other are considered relevant and appropriate, since they apply to permitted landfills or municipal landfills, of which WDI was neither. Table 2-3 provides a more detailed discussion of the ARARS.

TABLE 2-2, APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS				
	Citation	**Requirement Description**	**A**	**RA**
ACTION SPECIFIC	Hazardous Waste Control Act (HWCA)	The HWCA provides the state law for the management of hazardous waste including the state criteria for the identification of hazardous waste and standards for the design, operation, and closure of hazardous waste TSD facilities. While this program closely parallels the RCRA program, it contains some components with requirements in excess or more stringent than RCRA.		
	• Permitted Hazardous Waste Facilities	Requirements for RCRA TSD facilities are not applicable because the proposed closure activities do not include treatment, storage, or disposal of RCRA hazardous wastes. However, some of the requirements are generally considered relevant and appropriate because the remedy's closure of the unit is similar to a RCRA landfill or surface impoundment.		
	- Monitoring for Interim Status and Permitted Facilities, 22 CCR § 66264.90	This article contains the requirements for the environmental monitoring of air, soils, and water for on-site facilities that treat, store, or dispose of hazardous waste. General requirements include a provision for groundwater monitoring. In addition, the requirements are relevant and appropriate for closure and post-closure monitoring assuming that the redisposed waste is hazardous.		X
	- Landfill Closure and Post-closure Care, 22 CCR § 66264.310	Closure of a landfill requires a final cover designed and constructed to : prevent the downward entry of water into the landfill for a period of at least 100 years; function with minimum maintenance; promote drainage and minimize erosion of the cover; accommodate settling and subsidence so that the cover's integrity is maintained; and have a permeability less than or equal to the permeability of natural subsoils present. After final closure, all post-closure requirements contained in 22 CCR 66264.117 through 66264.120, including maintenance and monitoring, must be complied with throughout the post-closure care period. In addition, a control system designed to collect gases emitted from the buried waste and convey these gases to a treatment device is required unless it is demonstrated that significant amounts of toxic or flammable gases will not be emitted from the buried waste.		X
	- Incineration Regulations			
	Incineration Waste Analysis, 22 CCR § 66264.341	This regulation contains the requirements for conducting an analysis of the waste feed to the incinerator.	X	

TABLE 2-2, APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS				
	Citation	**Requirement Description**	**A**	**RA**
ACTION SPECIFIC	Incineration Performance Standards, 22 CCR § 66264.343	This regulation sets forth the performance standards for an incinerator. These standards require that incinerators: - Achieve a destruction and removal efficiency of 99.99% for each principal organic hazardous constituent in the waste feed and 99.9999% for dioxins; - Reduce hydrogen chloride emissions to 1.8 kg/hr or 1% of the HCl in the stack gases before entering any pollution control device; and - Not release particulate in excess of 180 mg/dry standard cubic meter corrected for amount of oxygen in stack gas.	X	
	Monitoring and Inspections, 22 CCR § 66264.347	This regulation requires monitoring of various parameters during the operation of an incinerator. These parameters include: combustion temperature; waste feed rate; an indicator of combustion gas velocity; and carbon monoxide. The regulation also requires daily visual inspections of the incinerator and weekly testing of the emergency waste feed cutoff system and associated alarms.	X	
	Fugitive Emissions, 22 CCR § 66264.345(d)	This section requires that fugitive emissions be controlled by: (1) keeping the combustion zone sealed; (2) maintaining a combustion-zone pressure lower than atmospheric pressure; or (3) an alternate means of control demonstrated to provide fugitive emissions controls	X	
	Closure, 22 CCR § 66264.351	This section requires that at closure all hazardous waste and hazardous waste residues (including ash, scrubber waters and scrubber sludges) be removed from the incinerator site.	X	

TABLE 2-2, APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS				
	Citation	Requirement Description	A	RA
ACTION SPECIFIC	Porter-Cologne Water Quality Act, 23 CCR 1050-2836	This act provides broad statutory authority to protect water quality by regulating waste disposal and requiring hazardous waste cleanup. Regulations for monitoring and corrective action pertain to "persons responsible for discharges at waste management units which are closed, abandoned, or inactive on the effective date of the regulations." Porter-Cologne also delegates standard-setting authority to the Regional Water Quality Control Boards (RWQCB).		
	• Water Quality Monitoring for Classified Waste Management Units, 23 CCR 2550	Monitoring is required to detect leaks from waste management units and a corrective action program is required if leaks are detected. A waste management unit is broadly defined as an area of land where hazardous, designated, or non-hazardous waste is discharged. Owners and operators of new or existing landfills and surface impoundments shall monitor groundwater, surface water, and the unsaturated zone as feasible. This requirement is relevant and appropriate, and generally complements the state HWCA monitoring requirements.		X
	Air Resources Act, Health and Safety Code Division 26, § 39000 et seq.	Regulates both non-vehicular and vehicular sources of air contaminants in California. Defines relationship of the Air Resources Board and local or regional air pollution control districts (sometimes called air quality management districts). Established Ambient Air Quality Standards and permit procedures.		
	South Coast Air Quality Management District (SCAQMD) Rules and Regulations			
	• Rule 401 - Visible Emissions	Limits visible emission from any point source to Ringelmann No. 1, or 20 percent opacity for 3 minutes in any hour.	X	
	• Rule 402 - Nuisance	Prohibits the discharge of any material (including odorous compounds) that cause injury or annoyance to the public, property, or business or endanger human health, comfort, repose, or safety.	X	
	• Rule 403 - Fugitive Dust	Limits on-site activities so that the concentrations of fugitive dust at the property line shall not be visible and the downwind particulate concentrations shall not be more than 100 micrograms per cubic meter, averaged over 5 hours, above the upwind particulate concentration. The rule also requires every reasonable precaution to minimize fugitive dust and the prevention and cleanup of any material accidentally deposited on pave streets.	X	
	• Rule 404 - Particulate Matter (Concentration)	Rule 404(e) limits particulate emissions for given gas flow rates.	X	

TABLE 2-2, APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

	Citation	Requirement Description	A	RA
ACTION SPECIFIC	• Rule 405 - Solid Particulate Matter	Establishes allowable discharge rates for particulates at rates of 0.99 to 30 pounds per hour.	X	
	• Rule 407 - Liquid and Gaseous Air Contaminants	Limits carbon monoxide emissions to 200 ppm and sulfur dioxide emissions to 500 ppm averaged over 15 minutes. The sulfur dioxide limit does not apply if the incineration source meets the provision of SCAQMD Rule 431.1. This rule applies based on the assumption that auxiliary fuel will be required for incineration.	X	
	• Rule 408 - Circumvention	A person shall not build, erect, install, or use any equipment, the use of which reduces or conceals an emission which would otherwise constitute a violation.	X	
	• Rule 473 - Disposal of Solid and Liquid Wastes	Incinerators designed to dispose of combustible refuse at burning rates greater than 50 kilograms per hour shall not release particulate matte in excess of 0.23 grams per cubic meter of gas calculated to 12 percent of carbon dioxide.	X	
	• Regulation IX - Standards of Performance for New Stationary Sources	This regulation sets forth standards and criteria with which all new stationary sources of air pollution and all modified or reconstructed stationary sources of air pollution must comply. Some may be applicable or relevant and appropriate to certain alternatives.		X
	• Regulation X - National Emission Standards for Hazardous Air Pollutants	This regulation sets forth emission standards for hazardous air pollutants. The emission standards apply tothe owner or operator of any stationary source for which a standard is prescribed. This may be applicable or relevant and appropriate to certain alternatives.		X
	• Regulation XI - Source Specific Standards	This regulation sets forth source specific standards. Two of the rules issued under this regulation -- relating to excavation of landfill sites, and the control of gaseous emissions from inactive landfills -- may be applicable or relevant and appropriate.		
	- Rule 1150 - Excavation of Landfill Sites	This rule states that no person shall initiate excavation of an active or inactive landfill without an Excavation Management Plan approved by the Executive Officer of SCAQMD. The substantive requirements of this rule will be met without a formal Plan. The Plan should provide information regarding the quantity and characteristics of the material to be excavated and transported and shall identify mitigation measures including gas collection and disposal, encapsulation, covering of the material, and chemical neutralizing, which will be part of the design of the remedy.		X
	- Rule 1150.2 - Control of Gaseous Emissions from Inactive Landfills	This rule requires perimeter landfill gas monitoring probes to evaluate off-site migration and limits concentration of total organic content to 50 ppm over representative area of the landfill and maximum concentration compounds (measure as methane) to 500 ppm, at any point on the surface of the landfill.	X	

TABLE 2-2, APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS				
	Citation	**Requirement Description**	**A**	**RA**
ACTION SPECIFIC	California Integrated Waste Management Board, 14 CCR Chapter 3			
	• § 17773 - Final Cover	This regulation requires that a minimum thickness and quality of cover be placed over the entire surface of the final lift which meets the standards of 23 CCR, Subchapter 15, Section 2581 or that meet the standards set forth for an engineered alternative. The prescriptive standard must be not feasible and the alternative must be consistent with the performance goals of subsection (e) and afford equivalent protection against water quality impairment. Subsection (d) provides the basis for showing compliance with this standard is not feasible. Subsection (e) sets forth the following minimum performance goals for the thickness and quality of cover: (1) a need to limit infiltration of water, to the greatest extent possible; (2) a need to control landfill gas emissions; (3) the future reuse of the site; and (4) a need to protect the low permeability layer from desiccation, penetration by rodents, and heavy equipment damage.		X
	• § 17783-83.15 - Gas Monitoring and Control During Closure and Post-closure	During periods of closure and post-closure maintenance, landfill gases generated at the facility must be monitored and controlled. A minimum of quarterly monitoring is required, with more frequent monitoring required if results indicate the landfill gas is migrating or accumulating in structures. Gas control systems must be designed to (1) prevent methane accumulation in on-site structures; (2) reduce methane concentrations at monitored property boundaries to below compliance levels; (3) reduce trace gas concentrations; and (4) provide for the collections and treatment and/or disposal of landfill gas condensate at the surface. Subsection (c) indicates some of the gas control system components that may be included. Subsection (d) provides procedures in the event that on-site structure methane levels exceed prescribed levels. Subsection (e) requires monitoring and adjustment to ensure optimum efficiency of the gas control system.		X
	• § 17796 - Post-closure Land Use	This regulation sets forth requirements concerning post-closure land use. This includes developing several options for the proposed use of the site, maintaining the integrity of the cap, methane detection for surrounding structures, and placing restrictions on future development within 1,000 feet of the waste holding area.		X

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Potential remedial alternatives identified and screened were gathered from EPA, DTSC, and private industry documents. Experts in various fields of remedial technologies were also consulted concerning the appropriateness of a technology for the site.

Potentially applicable treatment technologies and process options for cleaning up the site are identified for both soils and subsurface gases. The technologies/process options are then evaluated and screened based on treatment effectiveness, implementability, and cost. Potentially applicable technologies are identified and screened for technical practicability and cost. Technologies and process options that were examined are listed in Table 3-3 at the end of this chapter.

There are some components of the screened technologies that are common to several alternatives. They are described in the subsections of Section 3.1. They will be presented in different combinations to form alternatives that will be developed and screened in Chapter 4.

3.1 Components of Alternatives

3.1.1 *Monitoring*

Monitoring is required by many of the ARARs identified in the previous chapter of this FS. Many of these requirements are based on actions taken at the site, and what contamination will be left after the implementation of the remedy; however, some generalizations can be made concerning the extent and detail of the monitoring. The monitoring requirements can be broken down into the three basic media: Soil Monitoring, Subsurface Gas Monitoring, and Groundwater Monitoring. Table 3-1 shows the costs per sample for each media. For quality assurance purposes, field and trip blanks, duplicates and spikes may also be obtained depending of the data quality objectives of the sampling.

- **Soil Monitoring:** This includes an inspection of the overall condition of the site to ensure that erosion and subsidence is not occurring. Soil samples would be taken in the vicinity of surface contamination, particularly in the pesticide/PCB contaminated area and the area above the reservoir. The samples would be taken to a depth of two feet to monitor any changes in site conditions.

- **Subsurface Gas Monitoring:** The vapor wells located on the site would be sampled to determine the composition of gases existing in the soils of the site. Since wells exist both inside and surrounding the reservoir, these will be used to determine if gas migration is occurring. This sampling may also include sampling of surrounding structures located on-site and near WDI (St. Paul's High School, for example). Some remedies may require placement of additional vapor wells in order to conduct multiple-depth sampling. In addition, ambient air sampling may be performed to identify any gases escaping to the surface.

- **Groundwater Monitoring:** Although this Feasibility Study addresses only the soils contamination, monitoring of the groundwater may be required by some of the evaluated alternatives. The samples would be analyzed for organic and inorganic constituents. The number and location of the wells will be determined after further investigation has been completed. However, sampling will be done in the various water-bearing zones beneath WDI to evaluate the migration of contaminants. Additional wells may be required to accurately define the background levels of constituents and define the downgradient extent of contamination.

Table 3-1, Monitoring Costs

Media	EPA Analytical Methods	Sample Cost
Soil Samples	8240 (volatiles) 8080 (pesticides) 8270 (semi-volatiles) Priority Pollutant Metals	$300.00 each 200.00 each 425.00 each 250.00 each Total $1,175.00 each
Subsurface Gas Samples	T014 (volatiles)	$300.00 each
Groundwater Samples	8240 (volatiles) ICP (metals) GFAA (for As, Pb, Th, Se) Cold Vapor (Hg)	$300.00 each $25.00 each 25.00 each 35.00 each Total $385.00 each

3.1.2 *Fencing and Revegetation*

This component is designed to restrict site access. The fence on the perimeter along Greenleaf Avenue and St. Paul's High School would be augmented to a minimum height of seven feet and topped with barbed wire and razor ribbon to prevent access by trespassers. The rest of the perimeter fence would be inspected and repaired where necessary. Figure 3-1 shows the configuration of the fence. This corresponds to the location of the reservoir, and basically fences all the undeveloped property on the site, where contact with contaminated soils could occur. The vegetative cover at the site would continue to be maintained to prevent inhalation of any site dust that may be contaminated. Areas with exposed soil would be revegetated with native plants. The estimated capital cost for fencing the site is approximately $30,000.

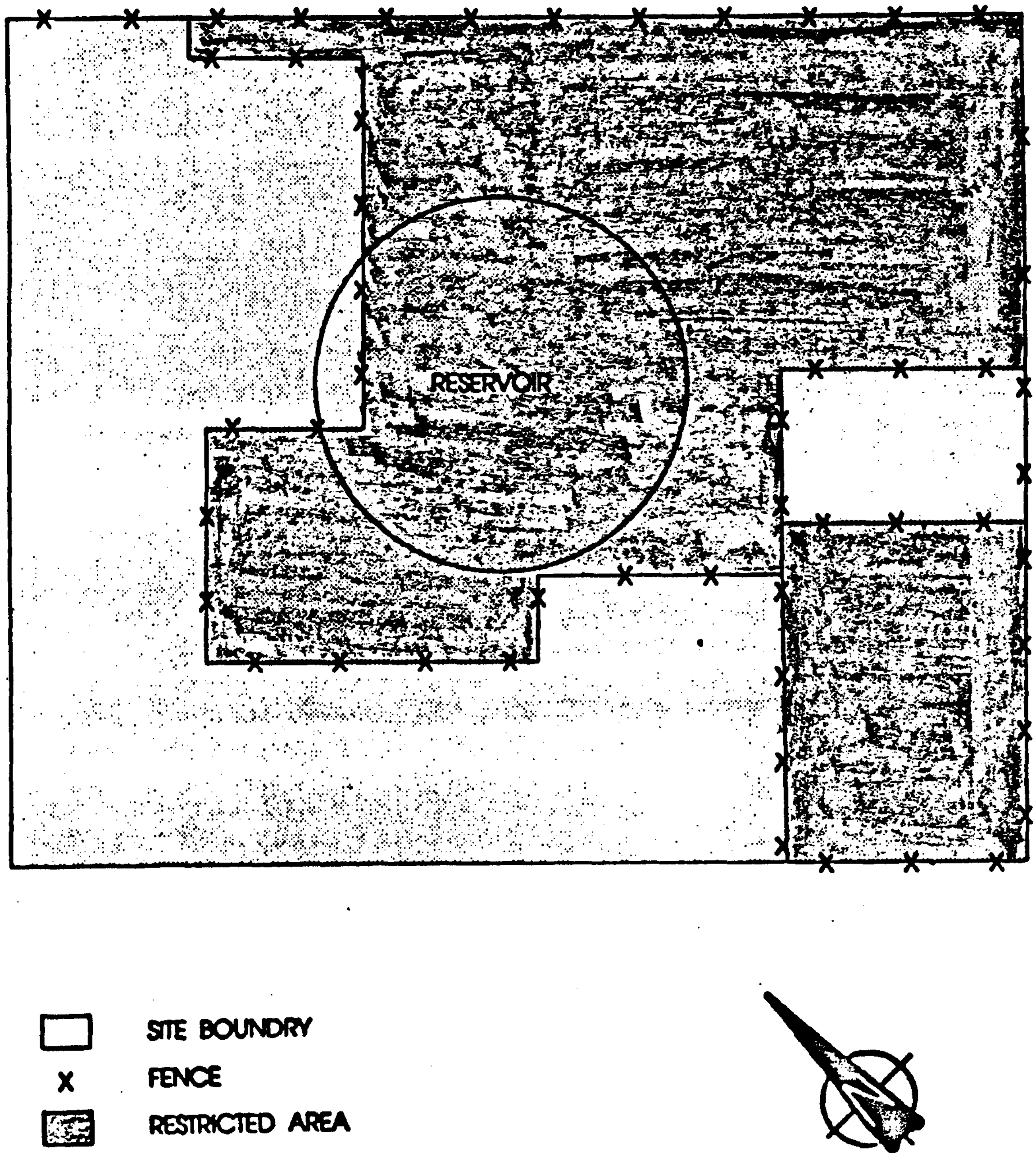


Figure 3-1, Fencing Diagram

3.1.3 *Institutional Controls*

Institutional controls are legal restrictions placed on a property to restrict certain types of use. In general, institutional controls fall into two major categories, (1) government controls, imposed by state or local governments, which restrict land use; and (2) proprietary controls, such as deed restrictions, whereby a party holding an interest in a parcel of property restricts the use of that property. The purpose of institutional controls is to prevent use of the site that could facilitate contact with contamination. Depending on the alternative, the institutional controls can vary from a notice on the deed stating that contaminated soil is present on the property, to permitting no excavation or digging on the property or requiring monitoring in any structure built on or near the parcel. Institutional controls can also restrict the use of groundwater under the property. The restrictions will vary depending on the conditions that exist at the property. Administrative tools such as institutional controls have little cost, but require diligence to enforce.

3.1.4 *Excavation*

The excavation options range from removing only surface (less than five feet) contamination at specific locations to complete removal of all contaminated soil, including the reservoir material. The alternatives will present the areas, if any, that are proposed for excavation and a volume estimate. The depth of excavation will relate directly to the type of institutional control ultimately imposed on property where contaminated materials are left in place.

For the purposes of this analysis, the cost of excavation is estimated at $10 per cubic yard. Other costs associated with excavation include replacing the removed soil with clean fill, estimated to cost approximately $0.10 per cubic yard. The actual cost will depend on the quality of the fill, the sampling to ensure that it is clean, the future use of land and the construction requirements for the fill. Compacting the soil may also be required.

3.1.5 *Capping*

Capping is considered a containment option. With this action, the direct contact with contaminated material would be eliminated by placing a barrier over the site. Preventing the infiltration of rainwater into the contaminated soil and flushing contaminants into the groundwater is also accomplished by most caps. The "cap" can be made of various materials and range in thickness depending on the number of layers and types of material prescribed.

The simplest cap is the soil covering that already exists at the site. While there are spots of surficial contamination, the existing cap prevents direct contact with contamination beneath its surface, approximately 5-15 feet below ground surface. It does not prevent rainwater infiltration, however.

A second type of soil cap would require placing a layer of compacted clay across the site, then covering the site with soil suitable for vegetation. Revegetating the soil aids in erosion prevention, while the compact clay layer prevents rainwater from infiltrating the soil and contaminating the groundwater.

An asphalt cap is similar in construction to a parking lot, although with a flexible membrane liner, it is a little more sophisticated and protective. It consists of an asphalt layer underlain by gravel. This type of cap prevents rainwater intrusion, and doesn't experience erosion problems that a soil cap might. If properly constructed, an asphalt cap can meet the RCRA requirements that are relevant and appropriate to closure of a landfill or surface impoundment.

The most complex cap is a RCRA cap that meets all of the requirements set out in 40 CFR § 264.111 and § 264.310, as well as EPA guidance on Final Covers on Hazardous Waste Landfills and Surface Impoundments. This is a multi-layer cap, complete with a gas collection layer, a water drainage layer, a biotic layer to prevent intrusion by animals or plant roots, and several thin plastic liners to ensure no migration of gases to the surface or rainwater into the groundwater. The surface of the RCRA cap can be either asphalt or topsoil and vegetation. A hybrid cap incorporates some of the layers of the full-blown RCRA cap.

The costs of the different caps vary greatly. The cost of fill dirt, as stated above, is estimated at approximately $\$0.10/yd^3$. The cost of quality topsoil (for the vegetation options) can be much more expensive, up to $\$1.00/yd^3$. Asphalt in the Los Angeles area costs approximately $3.00 per square foot of paving. Based on the Best and Final Offer by Chemical Waste Management for the Selma Remedial Action in July 1992, the cost of a RCRA Cap is $660,000 per acre, or approximately $\$15.15/ft^2$.

3.1.5.1 Gas Collection System

Gas collection and treatment is an option for the capping alternatives. Capping can prevent the natural permeation of gases through the existing soil cover, causing gas migration laterally under the cap and gas release along the perimeter.

There are two types of gas venting, passive and active, that can be employed with cap. A passive system utilizes the natural upward migration of light gases and channels them to the desired point. The gas can then be vented to the ambient a concentrations are low, or treated via carbon adsorption or thermal destruction.

An active system utilizes vapor wells to extract gases generated in the soil, pull them to the surface for treatment. Since methane is the main constituent of co in landfill gases, treatment usually consists of simple flaring. This can be accomplished if the percentage of methane is high enough to allow combustion. If the concentration of methane is too low, another form of treatment would be employed, usually carbon adsorption. Treatment of the exhaust may also be required, depending on the concentration of chlorinated compounds in the gas. Usually this is accomplished with a wet scrubber.

A passive venting system would be fairly inexpensive to implement, while an active system can require complex equipment. Since there are already vapor wells located within and surrounding the reservoir, they could be employed in an active system without drilling more wells. A combination of active and passive venting can also be employed to facilitate the removal of the landfill gases. Further investigation during design will quantify the amount of gas migrating to the surface to determine which system, if any, will be appropriate for the chosen remedy at WDI.

3.1.6 *Incineration*

Incineration, either on- or off-site, involves the thermal destruction of contaminants. This technology is presented as a treatment option for excavated soils. There are basically two types of off-site incinerators, Rotary Kiln and Cement Kiln incinerators. On-site incineration would be accomplished with a mobile unit. Mobile units are similar to the off-site incinerators, but the contaminated soils can be treated much less expensively on-site.

The cost for off-site incineration, based on estimates received by EPA for the McColl Superfund site, is approximately $1510/ton. This includes the transportation cost for the contaminated soil to the Chemical Waste Management facility located in Port Arthur, Texas, the closest facility that accepts bulk shipments for disposal. The estimated costs are $310/ton for transportation and $1200/ton for incineration and ash stabilization and disposal.

A mobile incineration system is commercially available that is based on rotary kiln technology. The primary system consists of a waste feed handling system, a rotary kiln incinerator, and afterburner, and a flue gas cleaning system. Based on engineering estimates for the Purity Oil Superfund site, and the experiences in other regions of the country, the cost of on-site incineration is approximately $175/ton.

3.1.7 *Off-site Disposal of Excavated Soil*

Excavated soils that are contaminated could be disposed at a hazardous waste landfill. Based on the Purity Oil Superfund Site Feasibility Study costs estimates, disposal at the Chemical Waste Management, Inc. (CWMI) site at its Kettleman City Hazardous waste landfill would cost $225/ton. This includes excavation and transportation to the California facility.

3.2 Technologies and Process Options Retained for Evaluation

Based on the evaluation and screening of technologies and process options in Table 3-3, the following alternatives were developed for further evaluation and screening. Table 3-2 shows the combination of the above described components into alternatives that will be further developed in Chapter 4.

Table 3-2
Summary of Technology Screening

GENERAL RESPONSE ACTIONS	REMEDIAL TYPE	TECHNOLOGY/ PROCESS OPTIONS
NO ACTION	Monitoring Only	---
ADMINISTRATIVE ACTIONS	Limit Access/ Institutional Controls	Chain Link Fence, Land Restrictions and/or Groundwater Use Restrictions, Monitoring
CONTAINMENT	Capping	Hazardous Waste Cap Asphalt Cap Soil Cap Passive or Active Gas Venting (with or without treatment)
EXCAVATION	Excavating contaminated soils	On-site consolidation Off-site disposal
THERMAL DESTRUCTION	Excavation and Incineration	Mobile Incinerator Off-Site Incineration

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
MINIMAL ACTION:				
Site Fencing	Usually constructed of steel chain link with barbed wire used to enclose a specified area. Restricts site access.	· Does not reduce toxicity, mobility, or volume (TMV). · Reliability depends on future maintenance. · Protective by reducing risk of direct contact with contaminated wastes and soil.	· Easily implemented. · Routinely used. · Periodic inspections and maintenance required.	Retained for further consideration.
Institutional Controls	All deeds for property within potentially contaminated areas would include permanent restrictions on the future use of the property, including well drilling and excavation restrictions. Parcels without subsurface contamination would not be restricted. Alternatively, the state or local government would impose land use restrictions by law or administrative action.	· Does not reduce TMV. · Protective by reducing risk of direct contact with contaminated soil. · Reliability depends upon implementation and future enforcement.	· Easily implemented. · Enforcement may be difficult. Enforcement also uncertain since it is usually the responsibility of the local government.	Retained for further consideration.
REMOVAL:				
Conventional Excavation	Contaminated soils would be removed with common construction equipment.	· Does not reduce TMV. · Effective at removing contaminated soils. · Required for subsequent treatment/disposal. · Removal could release volatile organics (residents nearby). · Dust generation during removal could impact short-term effectiveness.	· Easily implemented using common construction equipment. · Recovery of free product from areas may be required prior to excavation. · May require stabilization and air pollution controls to reduce possible vapor emissions and odors.	Retained for further consideration.
Leachate/Free Product Extraction Wells	Free product would be removed from sumps with wells.	· Does not reduce TMV. · Effective at removing free liquids. · Required for subsequent soil excavation and will require treatment and disposal. · Removal could release volatile organics.	· Relatively easy to implement using common construction equipment. · Construction may require special precautions and measures due to volatile and explosive gases. · Further study may be required to strategically locate wells within sumps.	Eliminated due to insufficient liquids to warrant consideration.

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
Infiltration Trench	Free product would be collected in a common wet well where it will be withdrawn.	· Does not reduce TMV. · Effective at removing free liquids. · Network of trenches more effective than wells at collecting free product from sumps with very heterogeneous materials. · Removal could cause volatilization of organics.	· Easily implemented using common construction equipment and readily available materials. · Collapsing of trench side walls may complicate construction; use of sheet piling necessary under these conditions. · Lack of bottom confining layer could result in waste migrating underneath trenches.	Insufficient liquid at the site to retain for further consideration.
Enhanced Oil Recovery	EOR is used in oil field technologies for recovering as much oil as is economically feasible. This technology consists of injecting materials into the oil bearing formation and forcing oil out by thermal, chemical, or physical displacement.	· Does not reduce TMV. · Effective at removing approximately 40% of oil originally in place.	· Methods require confined formations for implementation. · Positive displacement can cause greater migration of contaminated materials and volatilization. · Has not been demonstrated at hazardous waste sites.	Eliminated due to insufficient oil and lack of demonstration at hazardous waste sites.
CONTAINMENT:				
Soil or Asphalt (RCRA-equivalent) Cap	Cover contaminated soils with a single layer or multi-layer cap of low permeability material such as soil, asphalt, concrete, and/or a synthetic membrane to contain contaminated soils.	· Reduces contaminant mobility and risk of direct contact and inhalation; however, contaminants remain in place. · Reliability is dependent on future maintenance and use. Some types of caps may crack leading to potential exposure.	· Construction is relatively easy. · Long-term monitoring and maintenance is required since cap may be subject to cracking due to differential settling or leaking and membranes may tear or deteriorate. · Can be constructed with minimal change in site grades.	Retained for further consideration depending on land use restrictions.
Full RCRA Cap	A multi-layered RCRA cap which combines several layers of cover materials such as soil, synthetic membranes, and clay to provide erosion and moisture control, in addition to containing the contaminated soils.	· Reduces mobility of contaminants and risk of inhalation; however, contaminants remain in place. · RCRA cap is more effective in minimizing rain infiltration.	· Long term periodic inspection and maintenance required to prevent erosion and ensure cap stability. · Enforcement of deed restrictions to prevent damage to the cap. · Installation of cap would limit use of property, disrupt current site uses.	Maintained for further consideration.

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
HORIZONTAL BARRIERS:				
Synthetic Liners and Grout Injection	Technology consists of constructing a barrier of low permeability under the waste to minimize vertical migration of contaminants. Clay and synthetic membrane liners are well established technologies. In-situ liner construction techniques (ie, injection of grout to form a barrier underneath the waste) are not demonstrated so construction is limited to removing soils/ contamination to place liner. A capping system is required to limit infiltration.	· Reduces mobility but does not affect volume or toxicity of wastes. · Effectiveness in retaining contaminants must be evaluated by monitoring. · Dust generation and release of volatiles during excavation/installation could impact short-term effectiveness.	· Clay and/or synthetic membrane liners may be easily constructed using standard construction methods and materials. · Horizontal grout injection has not been widely used and has not been demonstrated at hazardous waste sites. · Installation could be difficult if excavation to greater than 40 feet is necessary. · Extremely large excavation volume, insufficient temporary storage area and need to demolish/excavate the reservoir make this technology very difficult to implement at the site.	Eliminated due to difficulty of implementation (for excavation) and lack of demonstration (for in-situ horizontal barrier).
VERTICAL BARRIER:				
Grout Injection/Slurry Wall/Sheet Piling	Technology consists of construction of barrier of low permeability to minimize lateral migration of perched groundwater, contaminated water or waste material. A capping system can be integrated with vertical barriers for greater control of waste material by reducing infiltration. Vertical barriers can be constructed by injecting grout from a row of wells; piles driven into the ground, while the piles are withdrawn; injecting grout from hollow augers while the augers mix the soil; excavating trenches and filling the trenches with bentonite slurry and driving sheet piling into the ground.	· Reduces mobility but does not affect volume or toxicity of wastes. · Effective in limiting horizontal migration of waste material. · Slurry walls are generally more effective than sheet pile walls and walls constructed by in-situ grout injection. · Waste material or contaminated water may escape below barrier. A continuous low-permeability zone into which the barrier walls can be keyed, does not exist at this site. · Can be incorporated with infiltration trench to direct flow to collection and withdrawal point.	· Vertical barriers may be easily constructed using standard construction methods and materials.	Eliminated since there does not appear to be a migration of contaminants in source area.

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
TREATMENT:				
Solids Processing	Consists of physically sorting and/or modifying the size distribution of the soils and other debris that may be excavated. Processes typically include crushing and grinding and sizing by screens or classifiers. Also includes slurrying, which involves the addition of water to solids so that the mixture can be pumped.	· Modifying the size distribution of soils is often required prior to treatment in process equipment or disposal. · May enhance subsequent treatment by liberating some hazardous constituents (such as volatile organics) from inert materials and increasing the specific surface area of soils. · Does not typically reduce toxicity or mobility or contaminants, but may reduce volume of contaminated material in certain cases.	· Requires significant materials handling. · Is required as a pretreatment for many treatment technologies. · Release of hazardous constituents during processing is a potential problem.	Eliminated due to increased short term risk caused by excavation of the waste.
Solids Dewatering	Process to remove excess (free) liquid from excavated saturated materials prior to treatment. May also be used to remove water in-situ to facilitate excavation or in-place treatment methods. Methods commonly used consist of filter presses, drying beds, sedimentation, gravity thickening, and centrifuge.	· Reduces moisture content of solids for subsequent treatment or excavation. · May be required prior to implementation of some treatment or disposal technologies. · Does not reduce mobility or toxicity of handles materials.	· May cause volatilization of contaminants. · Treatment of removed water, if required, could be combined with leachate or free product treatment technologies.	Eliminated due to increased short term risk due to excavation of waste.

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
Solidification	Consists of transforming excavated or in-situ contaminated soils and drilling liquids into a non-leaching form or creating a material which is easier to handle. Solidification processes may use a variety of materials including bentonite, Portland cement, pozzuolanic grouts, fly ash, and silicates.	· Limited data available to evaluate effectiveness of in-situ methods. For excavate material, considerable data available. · May increase the volume of contaminated material by addition of solidification agent. · Bench test required to evaluate reduction in mobility. · Effectiveness measured varies with test method used. · Proven effective in treatment for metals. Effectiveness for organics insufficiently demonstrated.	· Volume of immobilized soil will be increased. · Requires skilled labor, as it may be a complex process. · Long-term effectiveness must be evaluated by monitoring. · Treated end product requires disposal. · Treatability test required to determine type and ratio of stabilization material and determine level of effectiveness.	Retained for consideration as possible primary or support technology, treatment of metals in residuals from incineration process, or as treatment prior to land disposal. Will require treatability test to select most suitable type of reagent and demonstrate effectiveness for site organic contaminants. In-situ solidification eliminated due to coarseness and heterogeneity of soil and existence of cement liner in reservoir.
SOLVENT EXTRACTION:				
Soil Vapor Extraction	The process involves the in-situ air stripping of contaminated soils using a vacuum source. The technology volatilizes and removes some contaminants directly from the vadose zone.	· Vacuum extraction is effective for removing some VOCs from the vadose zone only. Non-volatile organics and other site contaminants unaffected. · Volatilized organics may pose a health risk in ambient air if not captured or treated.	· Although considered innovative, most components of the system are relatively simple to implement. · May require installation of a low permeability cap or cover over the system to increase its effectiveness. · May require some air filter system depending on exhaust concentrations.	Retained for possible implementation in conjunction with capping remedy for removal of landfill gases.

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
Soil Washing or Flushing	Contaminants are removed from excavated (washing) or in-situ (flushing) soils via solvent extraction. Contaminated solvents are recovered for subsequent treatment and/or disposal. Solvents include water, detergent, acids and other chemicals.	· Individual contaminants may require use of separate solvents. · Reduces volume of contaminants in soil; however, produces large volumes of contaminated solvents which require treatment. · Highly permeable soils increase effectiveness and reduces time required for flushing or washing. · Achievable level of contaminant removal may not be adequate to attain necessary action levels.	· Typically complex processes, difficult to implement. · Soil flushing requires special provisions to ensure complete collection of contaminated solvents. · Collected solvents require recycling and/or treatment to reduce toxicity. · Bench and/or pilot testing required. · Reliability of complete contact of solvent with all contaminated soils for in-situ soil flushing is questionable. · Soil washing for excavated soil is easily implemented for sand but more difficult for clays and drilling mud.	In-situ process is eliminated due to potential adverse environmental effects from difficulties in solvent collection and anticipated difficulty in implementation due to heterogeneity and low permeability of subsurface materials. For excavated soils, would require treatability study to demonstrate the effectiveness of the soil washing process. See below for further evaluation.
TEA Extraction	Extraction of organics from excavated soils is achieved by contacting the soils in a reaction vessel with a triethylamine (TEA) to extract contaminants.	· Reduces TMV of organics. · Produces small quantity of high concentration residual for disposal/treatment. · Removal is higher in media with high oil concentration. · Removal efficiency can reach 99% of original concentration. · Site concentrations may make achieving action levels difficult. · Pilot test facility is available for soils, sediments, and sludges.	· Typically complex processes, difficult to implement. · Pilot tests required. · Commercially available but limited supply of units.	Effective in treating semi-volatiles but treatability study required to demonstrate achievement of cleanup levels. There is no off-site facility with TEA extraction available; an on-site treatment unit is being developed. Eliminated from further consideration.

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
Critical Fluid Extraction	Fluids in their critical state are used to extract organics from excavated soils. Process used in laboratory & industry to remove organics.	· Reduces TMV of organics. · Reduces leachability of inorganics. · Achievable level of contaminant removal may not be sufficient to attain action levels. · Still in bench/pilot stage for solids. · Requires further treatment of small volume high concentration residual waste.	· Availability problematic due to early stage of development.	Eliminated due to only early stages of development, not applicable to metals and other site contaminants.
Chemical Oxidation	Oxidation reagent added to hazardous material oxidizes hazardous constituents, making them less or non-toxic. Some by-products may be effective on some sludges or slurries.	· Effective in reducing TMV. · Reaction is dependent on oxidant dosage, pH, oxidation potential, and the formation of stable intermediates.	· Requires high dosage of reagent with high strength wastes (>2,000 ppm). · Varied waste stream require different oxidation agents.	Eliminated due to high concentration of total petroleum hydrocarbons present and varied waste stream.
BIOLOGICAL TREATMENT:	The treatment of hazardous materials which are biodegradable. Introduction of micro-organisms and/or nutrients to contaminated media to promote and sustain the growth of the organisms which use organic contaminants as food. The metabolic process for aerobic biodegradation organics to water, carbon dioxide, halogens (from halogenated organics), and cellular material. Anaerobic biodegradation generates methane and possibly vinyl chloride.	· Effective in reducing TMV. · Volatilization of organics during treatment could pose a health hazard. · Organisms sensitive to certain levels of inorganics which will reduce efficiency or prevent biological degradation.	· Requires careful control of operation parameters due to the relative ease of upsetting biological process. · Equalization required to increase treatment efficiency by reducing perturbations in the feed stream.	Eliminated as biodegradation is not effective on high concentrations of PCB and DDT-contaminated soil.

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
THERMAL DESTRUCTION:				
Off-Site Incineration	There are a number of different types of incinerators available. Rotary kilns and multi-chamber fixed hearth systems are the most widely available. A rotary kiln introduces waste and auxiliary fuel at the high end of the kiln; wastes are thermally destroyed as they rotate through the kiln. Fluidized bed incinerators are also available.	· Reduces TMV for organics. · Performance data indicates that incineration is reliable and well demonstrated with high efficiency for destroying organic wastes. Will achieve target clean-up levels. · Ash would require proper disposal due to metals. · Pre-treatment of soils may be required to modify grain size distribution or moisture content. · Due to the large amounts of clays (drilling muds) present, conventional incineration systems will have difficulty with clays clumping to form hard solid masses.	· Currently, a limited number of operating facilities are located in the US. These facilities are typically running at capacity. · Excavation, drumming, loading, and transportation are necessary. · Incineration of clays is likely to produce a lot of dust, and efficient off-gas particulate handling equipment, such as a baghouse, will be required.	Retained for further consideration to treat excavated contaminated soils.
Off-Site Incineration (Cement Kiln, Co-disposal)	Cement Kilns and aggregate kilns are similar to rotary kiln incinerators but have a longer residence time. Solids with proper mineral characteristics may be mixed with other ingredients and introduced in the kiln, where organics are destroyed and the remaining material is incorporated into the product. Liquids with sufficient BTU content can be injected into the kiln as an auxiliary fuel source.	· Same as off-site conventional incineration; however, the clays would be incorporated into the cement or aggregate product and not reduce the effectiveness of the kiln to destroy organics. · Absence of a sophisticated air pollution control system would result in uncertain short-term effectiveness.	· Requires an existing cement or aggregate producing facility to accept contaminated material that has all necessary permits, and be in compliance with all pertinent regulations. · Requires a trial burn and permitting and an analysis of the environmental and health impacts.	Eliminated as there is a lack of facilities

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
On-Site Incineration	Same as off-site, except that a mobile incinerator would be brought on-site. Also, an infrared process is available for on-site incineration. Infrared consists of a primary chamber of carbon steel lined with layers of lightweight ceramic blanket. The infrared energy is provided by silicon carbide resistance heating elements. The material to be processed is conveyed through the furnace.	· Reduces TMV for organics. · Performance data indicates incineration is well demonstrated with high efficiency for destroying organic wastes. · Will achieve target clean-up levels. · Associated materials handling operations required. Currently, has been used at only a few hazardous waste sites. · Is not effective for metals treatment.	· Mobile and transportable units are available for on-site incineration. · On-site incinerator can treat large amounts of material at a lower unit cost than off-site incineration and eliminates transportation. · A mobile incinerator may require permitting if it is constructed and operated on a Superfund site, and must be in substantive compliance with all pertinent regulations. · Air pollution control equipment is typically required.	Retained for further consideration, however will probably be eliminated due to location of sensitive receptors (school and residents) and difficulties in meeting strict SCAQMD emissions standards.
IN-SITU THERMAL TREATMENT:				
Low Temperature Thermal Extraction	Volatile and some semi-volatile organic wastes are removed from the soil by introducing heated air into a reactor with the soil to strip contamination from soil. Soil excavation is required for treatment. The off-gas is then sent through an afterburner where organics are destroyed or condensed and collected.	· Has been demonstrated at other hazardous waste sites to remove certain organics from soils. · Not proven and not likely to remove some non-volatile contaminants and not effective for metals. · Reduces volume of waste. · Volatilized organics may be destroyed providing long-term effectiveness.	· Implementable. Could be constructed on-site or pre-assembled mobile units could be transported to the site.	Eliminated due to inability to effectively strip non-volatiles and semi-volatiles which may be highly absorbed to clay
Vitrification	Electrodes inserted into soils (in-situ) containing significant levels of silicates. Graphite is placed on the soil surface to connect the electrodes. The heat generated from this system causes a melt that gradually works downward through the soil. Inorganics and some organics are trapped in the melted silicates that cool to a form of obsidian (ie, very strong glass). Other organics are destroyed in process.	· Highly effective in reducing TMV of contaminants. · Destroys organic contaminants and binds up all other contaminants in glass-like mass. · Unproven in large-scale applications at hazardous waste sites.	· Currently only a few transportable units are available for use. · On-site generation of approximately 4 MW of electricity may be needed. · Can be used in unsaturated and saturated soils with moderately low permeabilities ($<10^{-3}$ cm/sec).	Eliminated because not demonstrated for treating large volumes of contamination, and the high concentration of organics may ignite uncontrollably.

Table 3-3
Screening of Potential Source Control Techniques at WDI

RESPONSE ACTION Process Options:	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	SCREENING COMMENTS
Radio Frequency Heating	This technology involves heating the subsurface soils with radio frequency waves to thermally decompose, vaporize, and distill hazardous constituents. Vapors emitted from the soils are collected for treatment in a vapor barrier above the surface. Primarily tested on hazardous waste landfills.	· At the conceptual design stage; reliability is unproven. · Bench scale testing and pilot studies will probably be required.	· Electrical power source will be required. · Non-uniformity of construction debris may make confinement of radio waves ineffective.	Eliminated due to experimental nature of technology, and the non-uniformity of contaminated media due to construction waste co-disposal.
DISPOSAL:				
On-Site Landfill	Contaminated solids are excavated and disposed of in a lined disposal facility constructed on-site. This technology would incorporate the cap and horizontal barrier technologies described in the previous containment technology section.	· Reliable method to contain wastes. · Volume or toxicity of waste is not reduced. · Protective by reducing direct exposure to contaminated materials.	· Water-saturated materials would require either chemical solidification or mechanical dewatering prior to landfilling. · Continued maintenance and long-term monitoring is required. · Potential long-term contamination problems with waste remaining on-site.	Eliminated, since capping will provide similar effectiveness without the increased short-term risks associated with excavation.
Off-Site RCRA Landfill	Soils from contaminated areas excavated, transported, and disposed at a RCRA-approved off-site landfill.	· Effective in reducing health risks posed by this media. · Would contribute to the protection of public health and environment by reducing exposure to site contaminants. · Volume or toxicity of waste is not decreased. · Volatilization of organics during excavation and transportation could pose a health hazard.	· Materials not defined as solids would require either chemical solidification or mechanical dewatering prior to landfilling. · Potential for long-term contamination problems with waste placed in landfill. · Off-site landfill would require trucking of a large quantity of contaminated material, which may not be administratively feasible. · Off-site landfill capacity is limited. · Increased risk of exposure during excavation/ transportation. · Waste streams would require treatment prior to disposal to comply with the LDR.	Retained for further consideration.

4.0 ANALYSIS OF REMEDIAL ALTERNATIVES

The purpose of this section is to further develop and screen alternatives for soils based on the options developed in Chapter 3. The alternatives are screened by evaluating the effectiveness, implementability, and cost of each alternative. The effectiveness criterion focuses on (1) the degree to which an alternative reduces contaminant toxicity, mobility or volume through treatment, (2) minimizes residual risk, and (3) affords long term protection. The implementability criterion focuses on the technical and administrative feasibility of implementing the alternative. The cost criterion is the cost of an alternative relative to the costs of the other alternatives.

4.1 Remedial Alternatives

4.1.1 *Alternative 1: No Action*

The No Action alternative, required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300.430(e)(6)), is used as a baseline alternative against which other alternatives are judged. With this alternative, there would be no reduction of toxicity, volume or mobility of the contaminants. The only actions that would take place would be re-seeding of any areas where vegetation was disturbed by on-site activities during the investigation, periodic monitoring required by CERCLA (because wastes will be left on-site), and five year reviews to evaluate site conditions over time.

The barrels of investigation derived wastes (IDW) would be properly disposed off-site.

4.1.2 *Alternative 2: Fencing, Revegetation, and Institutional Controls*

Site access would be restricted under this alternative. The site would be fenced to prevent contact with the exposed soil areas of the site. The perimeter fence along Greenleaf Avenue and St. Paul's High School would be augmented to a minimum height of seven feet and topped with barbed wire and razor ribbon to prevent access by trespassers. The rest of the perimeter fence will be inspected and repaired where necessary. Figure 3-1 shows the proposed fencing diagram for this alternative. Areas disturbed during the remedial investigation would be revegetated.

Institutional controls would be implemented to restrict land use. The purpose of these controls would be to prevent exposure to contaminated media, and could include placing a notice on the deed, preventing the use of the groundwater beneath the site, preventing development on parcels within the site boundary that could cause exposure to contamination, and restrictions on the use of the fenced parcels. While the property owners have discretion to propose end uses, EPA must ensure that the end use is consistent with the remedial goal, which is to protect human health.

Because wastes would remain on-site, annual monitoring along with a series of five-year reviews to evaluate changes in site conditions would be required for this alternative. Annual monitoring includes soil, subsurface gas, and groundwater media. Each five year evaluation would include a spatial and temporal analysis of existing data to determine increasing, decreasing or stationary trends in contaminant concentrations and emissions rates. The results of this evaluation would be used to maintain, increase or decrease the number of samples and analyses required for the monitoring program and determine the need for any other type of remedial action.

The subsurface gas is evenly distributed throughout the contaminated areas and filters through the existing cap in a way such that detectable levels have not been documented in the ambient air above the site. This alternative would therefore not require any additional treatment for the subsurface gas.

The barrels of investigation derived wastes (IDW) would be properly disposed off-site.

4.1.3 *Alternative 3: Containment*

There are four options to this alternative, all of which entail some type of cap over the contaminated areas. Excavation is included for some of the options of this alternative. Excavated materials would be consolidated under the cap. Option A is a multi-layer soil cap, Options B and C are asphalt caps, and Option D is an impermeable hazardous waste RCRA cap. Institutional Controls would also be considered for any of the options of the containment alternative. Again, the goal of the alternative is to prevent exposure to contamination, and land use decisions would have to take exposure scenarios into consideration.

The containment options might also require a landfill gas venting and treatment system, since the gases would no longer be able to slowly permeate the existing soil cap and release to the atmosphere. With a cap in place, the landfill gases generated might migrate laterally from under the cap and infiltrate surrounding buildings. More testing and sampling would be done to determine the volume and extent of gas generation, but a venting remedy would be likely. To prevent migration of landfill gases, a combination of passive and active venting would be installed. Passive venting consists of perforated plastic tubing which provides gases with transport to the surface for treatment. The active portion of the system consists of a blower which would pull gases through the vapor wells installed in the reservoir to the surface. The treatment would be simple flaring of the gases, with any condensation generated from this process being contained and disposed off-site.

Because the wastes would remain on-site under the options of this alternative, 5-year reviews would be required. The annual monitoring strategy would include cap stability evaluations in addition to the monitoring prescribed for Alternative 2.

4.1.3.1 Option A: Multi-Layered Soil Cover

This option involves the installation of a multi-layered soil cap over all accessible waste handling areas and the reservoir. The lower layer would be a compact clay layer having a low permeability. The upper layer would be topsoil and vegetation. Option A provides erosion and moisture control and controls off-site migration of contaminated dust. The cap would cover approximately 860,000 square feet (approximation based on aerial photographs). This area corresponds to Areas 3, 4, 6, 7, and most of Area 2. (See Figure 4-1 for the cap area.) The barrels of soil from the remedial investigation (soils from the well drilling) would be consolidated under the cap.

Prior to capping, a fence system would be installed to restrict unauthorized personnel from entering the exclusion/work areas. During the remedial action, wind direction would be monitored to determine the potential pathways for off-site migration of airborne contaminants. An assessment of the impact of potential air pollution, noise, and traffic during remedial activities would be performed prior to implementation of the remedial alternative. Continuous monitoring for ambient volatile organic constituents, metals, and particulates would be conducted during the entire remedial action to determine the effectiveness of contaminant control.

Remedial activities would be coordinated with St. Paul's High School officials to prevent any possible risk to the students. Water and a polymer-based soil sealant would be used as needed to control dust with secondary containment features including temporary dikes, hay bales, and ditches to prevent any potential site run-off.

The entire site, with the exception of the areas presently in use would, remain fenced and posted. Land use restrictions would be implemented to prevent activities that might breach or damage the cap. Restrictions would also be implemented to prevent use of the groundwater in the shallow aquifer underneath the site. Prior to any land use decision, the site would undergo a comprehensive civil and structural engineering study to determine whether the reservoir and waste handling areas could support any activity.

4.1.3.2 Option B: Asphalt Cap without Excavation

This option would place six-inch asphalt cap (four inches of gravel overlain by two inches of asphalt) over any exposed soil areas of the site. This would provide an additional physical barrier between the contaminated soils and the surface population. Like Option A, no excavation of contaminated material would be done on the site. The only construction work would be consolidating the barreled IDW under the cap, and some potential addition of soil to even up site grade for installation of the asphalt cap. The asphalt would cover approximately 860,000 ft^2. Figure 4-1 shows the capped area for this option.

Installation precautions and monitoring activities would be the same as those for Option A. Land use restrictions would also be the same as described above.

4.1.3.3 Option C: RCRA-equivalent Asphalt Cap with Limited Excavation

This option is similar to Option A, but utilizes asphalt instead of soil. The cap material itself is similar to Option B, but would cover a smaller area of the site (because of the limited excavation) and an additional Flexible Membrane Liner (FML) underneath to reduce the possibility of rainwater infiltration. With the membrane liner and gas remedy system, this cap would meet the substantive requirement of the more extensive RCRA cap described as Option 4. For this reason, this option can be called a RCRA-equivalent cap. The estimated area covered by this option is 750,000 ft^2. Figure 4-2 presents the area to be capped and the areas to be excavated.

The same pre-capping precautions would be taken as those described for the other options, including upgrading the fence surrounding the site, monitoring wind direction and airborne contaminants during remedial activities, and coordinating remedial activities with St. Paul's High School. Soil excavated from surrounding contaminated areas would be consolidated under the asphalt over the reservoir area.

Monitoring requirements would be similar to those for Options A and B. Land use restrictions would also be the same as described for the previous options of this alternative.

4.1.3.4 Option D: Multi-Layered Hazardous Waste Final Cover

For Alternative 3, Option D, a multi-layered cap meeting the requirements for surface impoundment/landfill closure as defined 40 CFR 264.221 and 264.228 would be installed. The cap would cover approximately 750,000 square feet, which is basically the Reservoir area and surrounding subareas (approximation based on aerial photographs) and the same area as that of Option C, shown in Figure 4-2. Limited excavation would be done to consolidate contamination not currently contained and protected by asphalt or structures. This alternative would provide erosion and moisture control, prohibit upward vertical migration of contaminants (liquid, solid, gas/vapor) through a series of low permeability layers and synthetic liners, and inhibit off-site migration of contaminated soil. This option includes two additional synthetic liners and a compact clay layer in addition to the layers in Option A. As a final top layer, the RCRA cap could be either asphalt or topsoil with vegetation. See Figure 4-3 for a schematic of full RCRA cap structure.

The same pre-capping precautions would be taken as those described for the other options, including upgrading the fence surrounding the site, monitoring wind direction and airborne contaminants during remedial activities, and coordinating remedial

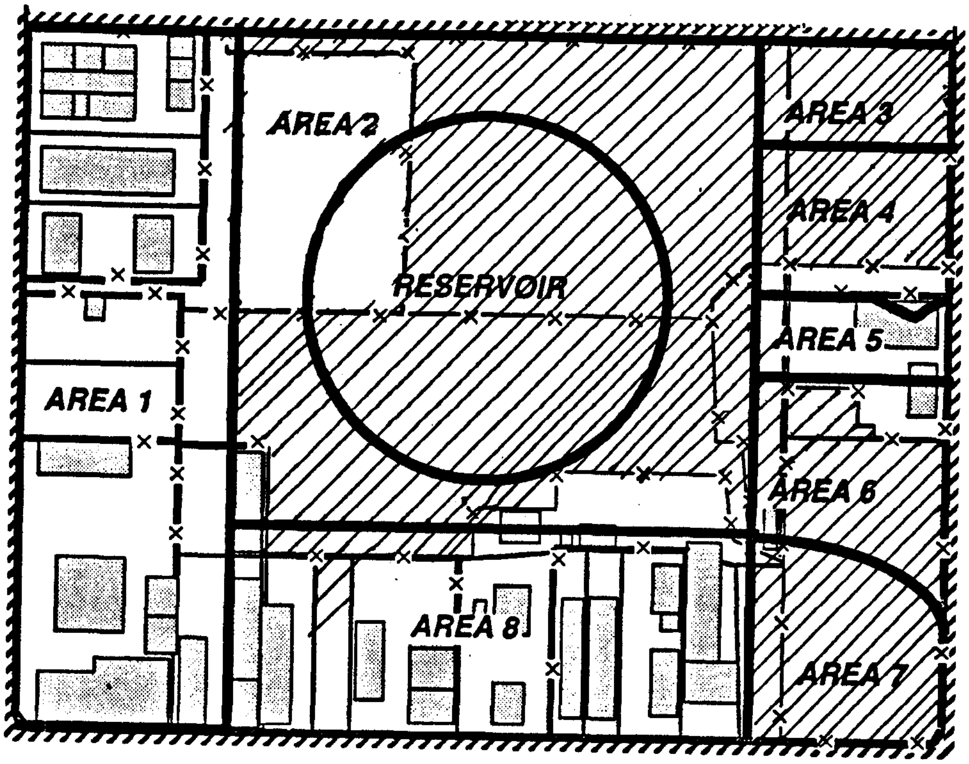


Figure 4-1, Area to be Capped for Alternatives 3A and 3B

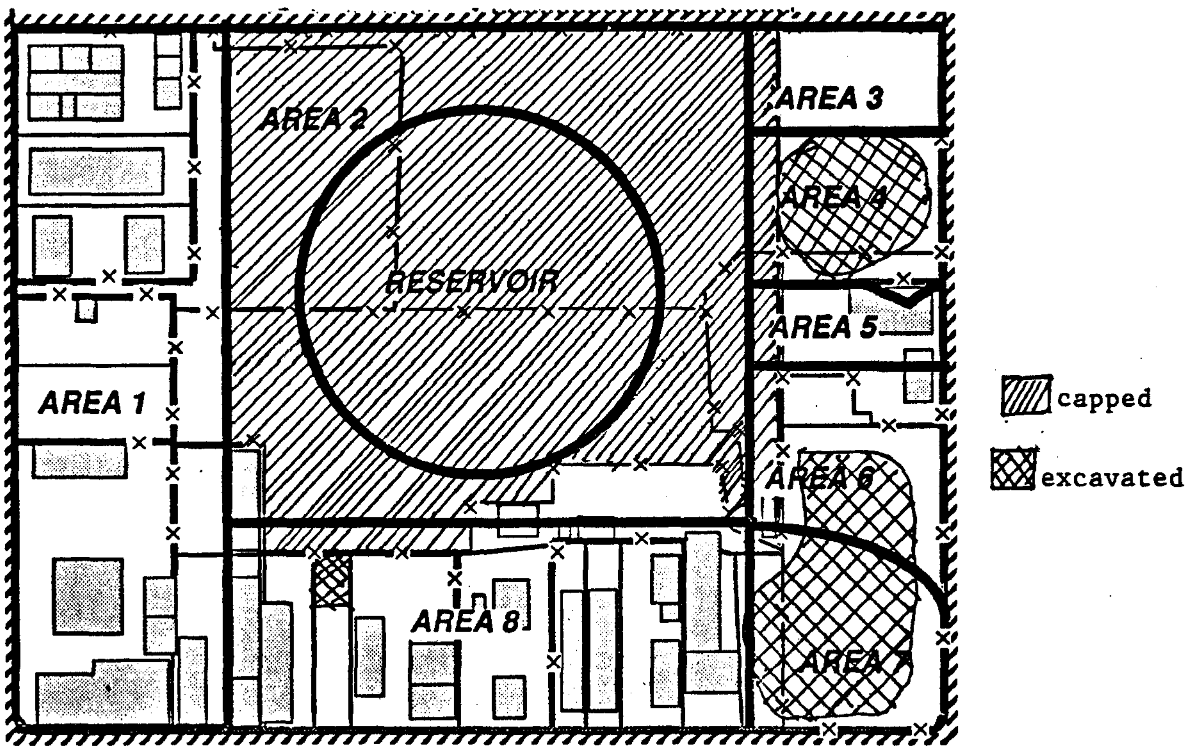


Figure 4-2, Area to be Capped for Alternatives 3C and 3D

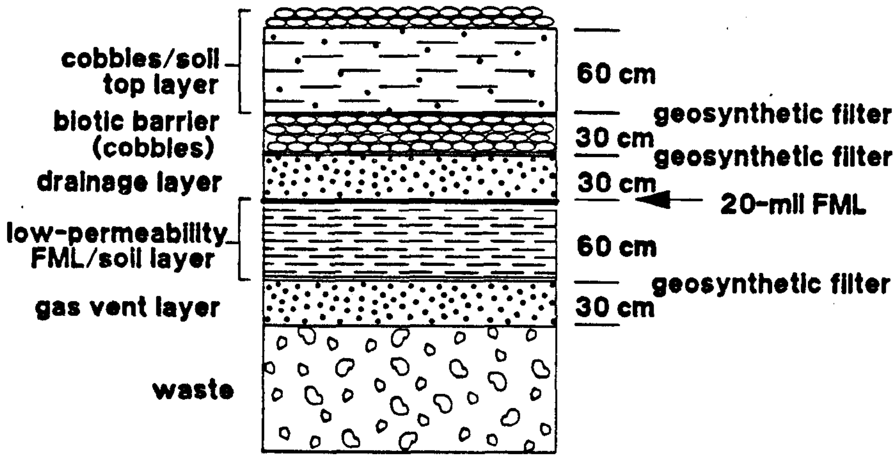


Figure 4-3, Cross-section Schematic of a Full-RCRA Cap (Alternative 3D)

activities with St. Paul's High School. Soil excavated from surrounding contaminated areas would be consolidated under the asphalt over the reservoir area.

Monitoring requirements would be similar to those for Options A and B. Land use restrictions would also be the same as described for the previous options of this alternative.

4.1.4 *Alternative 4: Excavation and Off-site Disposal*

This alternative would excavate contaminated material and dispose of it at an off-site facility permitted to accept wastes. There are two options to this alternative, (1) complete excavation of all contaminated soils at the site, including the reservoir and Area 2, and (2) excavation of only the areas described in the Alternative 3 options, with subsequent fencing and institutional controls of the reservoir area. Precautions would be taken to ensure that contamination would not migrate off-site during the excavation. An analysis of the subsurface gas would be done prior to excavation to determine whether excavation would be performed in conjunction with a gas collection and treatment system.

4.1.4.1 Option A: Excavation and Off-site Disposal, Fencing and Institutional Controls

This option would excavate the same areas described for Alternatives 3C and 3D (basically the undeveloped parcels with levels of contamination exceeding health-based levels). Since the reservoir and Area 2 would not be excavated, the area would be fenced and restricted to prevent future contact with contaminated soils.
The monitoring requirements would be similar to the other options, namely groundwater, soil, and subsurface gas sampling to track and analyze site conditions to ensure that the remedy is sufficient. Five-year reviews would also be conducted.

4.1.4.2 Option B: Complete Excavation of All Contaminated Soils

This option would excavate all contaminated soils (soils that exceed health-based risk levels) from the entire site. The volume of this material is estimated at approximately 640,000 cubic yards. The materials would be placed into containers and hauled to a licensed hazardous waste landfill.

Since all the contaminated soil would be removed from the site, there would be no further monitoring requirements for soils or subsurface gases. Groundwater monitoring would continue. There would also be no land use restrictions instituted at the site, since the excavation would remove any soils contaminated above health-based levels.

4.1.5 *Alternative 5: Incineration*

Both options under this alternative would necessitate complete excavation of the contaminated soils on the site. Cleanup goals would be established based on health risk to determine the exact extent of the contamination and amount of waste to be excavated. The same precautions would be taken as those for the excavation options to ensure that there is no impact to the surrounding community during the implementation of the remedy. Based on the criteria for selection of treatment alternatives under the FS process, a treatment or disposal option must be considered. Of the treatment or disposal options researched, incineration would be the most effective. There are two main categories of incineration that are considered here, (1) on-site incineration using a mobile incinerator and (2) off-site incineration.

4.1.5.1 Option A: On-site Incineration

This option would employ a mobile incinerator described in Section 3.1.6. The primary components of the mobile incinerator are the waste feed handling system, the rotary kiln incinerator, an afterburner, and a flue gas cleaning system (to comply with air emissions criteria). The contaminated soils would be excavated and fed into the incinerator. The resulting ash would be analyzed and disposed of properly. The estimated volume of soils to be incinerated is approximately 640,000 cubic yards.

4.1.5.2 Option B: Off-site Incineration

This option is similar to Alternative 4 Option B, Excavation and off-site disposal, since the same amount of material will be excavated and disposed, with the same packaging and handling procedures and costs. The main difference is that instead of disposing of the contaminated soil in a hazardous waste landfill, the soil would be transported to a hazardous waste incinerator for treatment. The resulting ash would be analyzed and disposed of properly by the incineration facility. Again, the estimated amount of contaminated soil to be excavated is 640,000 cubic yards.

Table 4-1, Preliminary Screening of Alternatives				
Alternative	**Effectiveness**	**Implementability**	**Cost**	**Status**
Alt 1: No Action	No active reduction of toxicity, mobility or volume (TMV) of chemicals of concern.	Implementable	Low	Retained
Alt 2: Fencing/ Institutional Controls	No active reduction of TMV of chemicals of concern, however, exposure to contamination reduced with effective administration of institutional controls.	Implementable	Low	Retained
Alt 3A: Multi-layered soil cap	No active reduction of toxicity or volume of chemicals of concern, but prevents infiltration of rainwater, reducing mobility to contaminants to groundwater, provides barrier preventing contact with contaminated soil.	Implementable, but would change site grade, affect drainage on site.	Moderate	Retained
Alt 3B: Asphalt Cap, No Excavation	No active reduction of toxicity or volume of chemicals of concern, but prevents infiltration of rainwater, reducing mobility to contaminants to groundwater, provides barrier preventing contact with contaminated soil.	Implementable. Site grade would change slightly. Little earthwork required.	Moderate	Retained
Alt 3C: RCRA-equivalent Asphalt Cap with Flexible Membrane Liner (FML), Limited Excavation	No active reduction of toxicity or volume of chemicals of concern, but prevents infiltration of rainwater, reducing mobility to contaminants to groundwater, provides barrier preventing contact with contaminated soil. FML enhances mobility reduction. Excavation increases short-term risk, but alternative is effective in the long-term.	Implementable	Moderate	Retained
Alt 3D: Full RCRA Cap	No active reduction of toxicity or volume of chemicals of concern, but prevents infiltration of rainwater, greatly reducing mobility to contaminants to groundwater, provides barrier preventing contact with contaminated soil. Excavation increases short-term risk, but cap is very effective in long term.	Implementable	Moderately high	Retained

Table 4-1, Preliminary Screening of Alternatives

Alternative	Effectiveness	Implementability	Cost	Status
Alt 4A: Excavation, Off-site Disposal, and Institutional Controls	No active reduction of TMV of chemicals of concern. Reduces risk of contact with surface contamination and subsurface soils not covered with asphalt. Excavation increases short-term risk.	Implementable	Moderately high	Retained
Alt 4B: Complete Excavation of Contaminated Soil	Removes contamination from site by off-site disposal. Excavation of reservoir can greatly increase short-term risks.	Not implementable. Requires excavation under existing structures. Very disruptive to existing businesses.	High	Not retained
Alt 5A: On-site Incineration	Reduces TMV of contaminants. Greatly increased short-term risk during excavation. Effective treatment for excavated soils. Very effective in long term.	Not implementable with excavation of all contaminated soils. Excavation very difficult, disruptive to existing businesses. Community opposition also to on-site incineration.	High	Not retained
Alt 5B: Off-site Incineration	Reduces TMV of contaminants. Greatly increased short-term risk during excavation. Effective treatment for excavated soils. Very effective in long term.	Not implementable. Excavation of all soils very difficult, disruptive to existing businesses.	Very high	Not retained

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 Evaluation Criteria

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR § 300.430 (iii) sets forth nine criteria to be used for a detailed, comparative analysis of the alternatives retained after the alternative screening portion of the Feasibility Study. The nine criteria are as follows:

- Compliance with ARARs
- Overall protection of human health and the environment
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The following sections describe each of the nine criteria.

5.1.1 *Compliance with ARARs*

Each alternative is evaluated for its compliance with applicable or relevant and appropriate requirements (ARARs), as defined in CERCLA Section 121 (f). The analysis summarizes which requirements are applicable or relevant and appropriate to an alternative. The following items should be considered for each alternative:

- Compliance with chemical-specific ARARs (e.g., MCLs for drinking water). This factor addresses whether the ARARs can be met, and if not, whether a waiver may be appropriate.

- Compliance with location-specific ARARs (e.g., preservation of historic sites, regulations relative to activities near wetlands or floodplains, etc.). As with other ARAR-related factors, this involves a consideration of whether the ARARs can be met or if a waiver is appropriate.

- Compliance with action-specific ARARs (e.g., RCRA minimum technology standards). It must be determined whether ARARs can be met or should be waived.

The evaluation also considers whether an alternative is in compliance with appropriate criteria, advisories, and guidance. It involves consideration of how well the alternative meets pertinent Federal and State guidelines that are not ARARs.

5.1.2 *Overall Protection of Human Health and the Environment*

The evaluation of the overall protection of human health and the environment for each alternative is based on a composite of factors assessed under other evaluation criteria. The criteria specifically considered are long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. For each alternative, it should include (1) how each source of contamination is to be eliminated, reduced or controlled and (2) how site risks are to be reduced, and if target levels are attained.

5.1.3 *Long-Term Effectiveness and Permanence*

The evaluation of a remedial alternative relative to its long-term effectiveness and permanence is made considering the risks remaining at the site after the response objectives have been met. The assessment of long-term effectiveness is made considering the following four major factors:

- The magnitude of the residual risk to human and environmental receptors remaining from untreated waste or treatment residues at the completion of remedial activities,

- An assessment of the type, degree, and adequacy of long-term management (including engineering controls, institutional controls, monitoring, and operation and maintenance) required for untreated waste or treatment residues remaining at the site,

- An assessment of the long-term reliability of engineering and/or institutional controls to provide continued protection from untreated waste or treatment residues, and

- The potential need for replacement of the remedy and the continuing need for repairs to maintain the performance of the remedy.

5.1.4 *Reduction of Toxicity, Mobility, or Volume (TMV) through Treatment*

This evaluation criterion addresses the degree to which remedial actions employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. The evaluation considers the following specific factors:

- The treatment processes,

- The amount of hazardous materials that will be treated,

- The degree of expected reduction in toxicity, mobility, or volume, including how the principal threat is addressed through treatment,

- The degree to which the treatment will be irreversible, and

- The type and quantity of treatment residuals that will remain following treatment.

5.1.5 *Short-Term Effectiveness*

The short-term effectiveness of a remedial alternative is evaluated relative to its effect on human health and the environment during implementation of the remedial action. The short-term effectiveness assessment is based on four key factors:

- Short-term risks that might be posed to the community during implementation of an alternative

- Potential impacts on workers during remedial action, and the effectiveness and reliability of protective measures

- Potential environmental impacts of the remedial action, and the effectiveness and reliability of mitigative measures during implementation

- Time until remedial response objectives are achieved

5.1.6 *Implementability*

The remedial alternatives must be evaluated to estimate the degree to which each can satisfy implementability criteria. Implementability refers to the technical, administrative, and environmental feasibility of implementing an alternative, and the availability of various materials and services required during its implementation. The following factors must be considered during the implementability analysis:

- **Technical Feasibility:** The relative ease of implementing or completing an action based on site-specific constraints, including the use of established technologies, including:

  - Ability to construct the alternative as a whole (constructability),

  - Operational reliability, or the ability of a technology to meet specified process efficiencies or performance goals,

  - Ability to undertake future remedial actions that may be required, and

- Ability to monitor the effectiveness of the remedy.

- **Administrative Feasibility:** The ability and time required to obtain any necessary approvals and permits from other agencies.

- **Environmental Feasibility:** The degree to which untreated wastes and treatment residuals remain within the 100-year floodplain or other environmentally sensitive areas. In addition, remedial alternatives which require excavation below existing fill depths may require a cultural resources survey.

- **Availability of Services and Materials:** The availability of the services and/or materials required to implement an alternative, including:

  - Available capacity and location of needed treatment, storage, and disposal services,

  - Availability of necessary equipment, specialists and provisions to ensure any necessary additional resources,

  - Timing of the availability of prospective technologies under consideration, and

  - The potential for obtaining bids which are competitive (this may be particularly important for innovative technologies).

5.1.7 *Cost*

For each remedial alternative, a detailed cost estimate is developed in accordance with procedures in the *Remedial Action Costing Procedures Manual* (USEPA, 1985). Cost estimates for each alternative are based on conceptual engineering and design, and are expressed in terms of 1992 dollars. The cost estimate for a remedial alternative consists of four principal elements:

- **Capital Cost:** Capital cost consists of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include the cost for equipment, labor and materials incurred to develop, construct and implement a remedial action, and the operation and maintenance cost for the first year after the construction is completed. Indirect costs are expenditures for engineering, financial, and other services that are not actually a part of construction, but are required to implement a remedial alternative.

- **Operation and Maintenance (O&M) Cost:** O&M cost refers to post-construction cost items necessary to ensure the continued effectiveness of a remedial action. They typically refer to long-term power and material cost (such as the operational cost of a water treatment facility), equipment replacement cost, and long-term monitoring cost.

- **Cost for Five-Year Review:** Section 121 (c) of CERCLA states that a five-year review of a remedial action is required if that remedial action results in hazardous contaminants remaining on-site. A discussion of the cost associated with five-year reviews is presented when applicable.

- **Present Worth Analysis:** This analysis is used to evaluate the capital and O&M costs of a remedial alternative on a present worth basis. Present worth analysis is a method of comparing expenditures for various alternatives that occur over different time periods. By discounting all costs to a common base year, the costs for different remedial action alternatives can be compared on the basis of a single cost figure for each alternative. The total present worth for a given alternative is equal to the full amount of all costs incurred until the end of the first year of operation (capital cost), plus the series of expenditures in following years reduced by the appropriate future value/present worth discount factor. This analysis allows the comparison of remedial alternatives on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. For the no-action alternative, a 30-year performance period is assumed for present worth analyses. A discount rate of 5 percent is assumed for base calculations. The discount rate represents the anticipated difference between the rate of inflation and investment return.

The Feasibility Study cost estimates are intended to reflect the actual cost of the remedial alternative with an accuracy of -30 to +50 percent.

5.1.8 *State Acceptance*

Formal comments made during the RI/FS review are evaluated and included in the final RI/FS. State comments on the recommended alternatives set forth in the Proposed Plan will also be addressed in the ROD.

5.1.9 *Community Acceptance*

Documented community positions on remedial alternatives are included in the RI/FS to assist with the remedy selection. A summary of public comments and responses to the Proposed Plan and recommended alternative will also be addressed in the ROD.

5.2 Analysis of Alternatives

In addition to balancing the nine criteria for each alternative, EPA has certain expectations for the remedy selected. The Preamble to the NCP states that "EPA expects to use treatment to address the principal threats posed by the site, whenever practicable. Principal threats are characterized as waste that cannot be reliably controlled in place, such as liquids, highly mobile materials (e.g., solvents) and high concentrations of toxic compounds (e.g., several orders of magnitude above levels that allow for unrestricted use and unlimited exposure)" (Preamble to the NCP, 55 FR 8703, March 8, 1990). There are no principal threats identified at WDI. Low risk threats are exposure to surface and subsurface contaminated soils and migrating subsurface gas. Most subsurface soils contaminant levels are below a 10^{-4} excess cancer risk.

The NCP also states that "EPA expects to use engineering controls, such as containment, for waste that pose a relatively low long-term threat or where treatment is impracticable." In addition, "EPA expects to use a combination of methods, as appropriate, to achieve the protection of human health and the environment. In appropriate site situations, treatment of the principal threats posed by the site, with a priority placed on treating waste that is liquid, highly toxic, or highly mobile, will be combined with engineering controls and institutional controls, as appropriate, for treatment residuals and untreated wastes" (40 CFR § 300.430(a)(1)(iii)(B) and (C)).

The following alternatives retained from Chapter 4 for further evaluation and comparison using the nine criteria are as follows:

- Alternative 1 - No Action
- Alternative 2 - Fencing, Revegetation, and Institutional Controls
- Alternative 3A - Multi-layer Soil Cap
- Alternative 3B - Asphalt Cap without Excavation
- Alternative 3C - RCRA-equivalent Asphalt Cap with Limited Excavation
- Alternative 3D - Full RCRA Cap with Excavation
- Alternative 4A - Limited Excavation, Off-site Disposal, Institutional Controls

5.2.1 *Overall Protection of Human Health and the Environment*

The overall protection of human health and the environment criterion assesses each alternative to determine its effectiveness in reducing risks at the site.

Alternative 1 offers no protection other than natural degradation and attenuation. Alternative 2 also relies on natural degradation and attenuation, provides an additional barrier to limit direct contact with site contamination. Institutional controls can provide additional warning of potential in addition to posted signs.

Alternative 3 options all provide progressively more protective barriers to contaminant exposure. Options A and B cover all exposed areas of contaminated soil without excavation, effectively preventing any direct exposure under current uses. Options C and D excavate much of the direct exposure risks and provide more protective and permanent containment on the contaminated material.

Table 5-1
Detailed Comparison of Overall Protection of Human Health and the Environment

Alternative 1 - No Action	• Existing risks remain, especially to trespassers • Infiltration of rain continues, may impact groundwater
Alternative 2 - Fencing, Revegetation, and Institutional Controls	• Existing risk remain, but trespassing deterred • Infiltration of rain continues, may impact groundwater • Institutional controls can alleviate some future risk by warning of actions that may lead to exposure
Alternative 3A - Multi-layer Soil Cap, Gas Venting and Treatment, Institutional Controls	• Existing risk due to direct exposure is controlled so long as cap integrity is maintained. • Rainwater infiltration controlled • Institutional controls can alleviate future risk by warning of actions that may lead to exposure, preventing breach of cap
Alternative 3B - Asphalt Cap , Gas Venting and Treatment, Institutional Controls	• Existing risk due to direct exposure is controlled so long as cap integrity is maintained. • Rainwater infiltration controlled • Institutional controls can alleviate future risk by warning of actions that may lead to exposure, preventing breach of cap
Alternative 3C - RCRA Equivalent Asphalt Cap with Flexible Membrane Liner (FML), Limited Excavation, Gas Venting and Treatment, Institutional Controls	• Existing risk due to direct exposure is controlled so long as cap integrity is maintained. • FML provides add extra infiltration protection and containment of migrating gases • Limited excavation consolidates contamination, reduces extent of contamination • Institutional controls can alleviate future risk by warning of actions that may lead to exposure, preventing breach of cap
Alternative 3D - Full RCRA Cap, Limited Excavation	• Controls existing risk so long as cap integrity is maintained (multiple layers provide added assurance that integrity will be maintained) • Rainwater infiltration prevented, landfill gas migration controlled • Institutional controls can alleviate future risk by warning of actions that may lead to exposure, preventing breach of cap
Alternative 4A - Limited Excavation, Off-site Disposal, and Institutional Controls	• Removes most contaminants that cause risk by direct exposure • Infiltration of rain continues, may impact groundwater • Institutional controls can alleviate some future risk by warning of actions that may lead to exposure

Alternative 4A removes from the site contaminated soil that pose a direct contact risk. Institutional controls are relied upon to prevent future contact with contamination remaining at the site, which is mostly beneath ground surface.

5.2.2 *Compliance with ARARs*

Only the options under Alternative 3 comply with all ARARs. All other alternatives fail to meet at least some of the identified ARARs. Table 5-2 presents a discussion of each ARAR and how it applies to the alternatives. (Since incineration alternatives have been screened out, incineration ARARs no longer need to be addressed.)

Table 5-3
Compliance with ARARs

HWCA - § 66264.90, Monitoring for Interim Status and Permitted Facilities	• Monitoring requirements will be met by all alternatives that leave contaminated material in place (Alternatives 1, 2, 3A, 3B, 3C, and 3D)
HWCA - § 66264.310 , Landfill Closure and Postclosure Care	• Maintenance and monitoring of the landfill containment will be met only by the containment options under Alternative 3
California Integrated Waste Management Board Regulations - § 17773, Final Cover	• The minimum requirements for thickness and quality of the final cover of the closed landfill will only be met by containment alternatives.
- § 17783, Gas Monitoring and Control During Closure and Post Closure	• Only containment alternatives address landfill gas monitoring and control; other alternatives allow permeation of gases through existing soil cover to the surface
- § 17796, Post-closure Land Use	• Integrity of final cover must be maintained. All alternatives except Alternative 1 require some institutional control to maintain integrity of landfill cover
Porter-Cologne Water Quality Act, § 2550, Water Quality Monitoring for Classified Waste Management Units	• All alternatives require groundwater monitoring and will meet this ARAR
SCAQMD Regulations	• These regulations apply to excavation work conducted at the site. The alternatives that require excavation (#3C, 3D, and 4A) will comply with these ARARs. They are not applicable to the other alternatives. Rule 1108.1 applies only to the alternatives that use an asphalt cover as part of the remedy (Alternatives 3B, 3C and possibly 3D, depending on the final layer selected for the RCRA Cap.)

5.2.3 *Long-term Effectiveness and Permanence*

Alternatives are assessed for long-term effectiveness and permanence, along with the degree of certainty that the alternative will be successful. Alternative 1 does not meet any of the criteria for long-term effectiveness, since no action will be taken at the site. Alternative 2 also provides little protection to prevent exposure to contaminants in the long-term, since the effectiveness of fencing is limited.

Table 5-4 Comparison of Long-term Effectiveness and Permanence	
Alternative 1 - No Action	• No long-term effectiveness or permanence other than natural degradation and attenuation
Alternative 2 - Fencing, Revegetation, and Institutional Controls	• Long-term effectiveness and permanence dependent on the deterrent capabilities of the fence (with High School athletic field next door, fenced area is likely to be accessed) • Institutional controls have limited effectiveness; EPA may have to rely on State or local government to enforce controls.
Alternative 3A - Multi-layer Soil Cap	• Moderate effectiveness in the long-term. With vegetation to prevent erosion, cap can maintain integrity through climate changes. Not an effective barrier to animals on-site, may not deter excavation since it would not "appear" to be an intentional barrier to prevent exposure to contamination. • Institutional controls have limited effectiveness; EPA may have to rely on State or local government to enforce controls.
Alternatives 3B and 3C - Asphalt Caps	• Effective in the long-term, dependent on maintenance of the cap. Asphalt can maintain integrity through climate changes; more difficult to breach • Institutional controls have limited effectiveness; EPA may have to rely on State or local government to enforce controls. • FML for Alternative 3C increases long-term effectiveness by providing extra impermeable layer
Alternative 3D - Full RCRA Cap	• Effective in the long-term, dependent on maintenance of the cap; configuration maintains integrity through climate changes; multiple layers provide very effective barrier to exposure; infiltration minimized; installation considered permanent • Institutional controls have limited effectiveness; EPA may have to rely on State or local government to enforce controls.
Alternative 4A - Limited Excavation, Off-site Disposal, and Institutional Controls	• Removal of surface soil contaminants is effective in long-term, permanent in removing associated risks from site • Waste remaining in place still poses long-term risk, potential source of contamination to groundwater, source of subsurface gases • Institutional controls have limited effectiveness; EPA may have to rely on State or local government to enforce controls.

The containment options under Alternative 3 increase in effectiveness with the number of layers; however the gas treatment system might require a wet scrubber or some other secondary treatment system, which will then have to be properly maintained, and any wastes properly disposed. This can reduce long-term effectiveness of the remedies if not performed correctly.

5.2.4 *Reduction of Toxicity, Mobility, or Volume through Treatment*

None of the alternatives retained from Chapter 4 incorporate a treatment technology, as the primary remedy; however, the containment options that employ the gas collection and treatment system do reduce the mobility and volume of the landfill gases generated beneath the surface. However, the containment options of Alternative 3 would prevent rainwater infiltration, ultimately reducing the mobility of contaminants found in the soil without any treatment of the contaminated soils. This, after all, is the main purpose for most cap designs.

5.2.5 *Short-term Effectiveness*

This criterion assesses the short-term risks to workers and the community during implementation of an alternative, potential short-term environmental impacts of the alternatives and the time until protection from any short-term risk is achieved.

Alternatives that propose excavation of contaminated soils (Alternatives 3C, 3D, and 4A) may pose a short-term fugitive dust risk to workers and the community. Dust control measures will be implemented, however. Alternative 4A requires the transportation of excavated contaminated soils, which poses an increased short-term risk to communities en route. Asphalt paving also increases short-term risk from emissions of the paving compounds. Gas venting and treatment system should not impact short-term risks.

Table 5-5
Comparisons of Short-term Effectiveness

Alternative 1 - No Action	• No increased short-term risks
Alternative 2 - Fencing, Revegetation, and Institutional Controls	• No increased short-term risks
Alternative 3A - Multi-layer Soil Cap	• A slight increase in short-term risk due to some earthwork required to grade the site prior to capping, but no excavation
Alternative 3B - Asphalt Cap	• An increase in short-term risk due to some earthwork required to grade the site prior to capping, and the installation of asphalt, which increases risk via emissions from the paving materials.

Table 5-5 Comparisons of Short-term Effectiveness	
Alternative 3C - RCRA-equivalent Asphalt Cap with FML, Limited Excavation	• An increase in short-term risk due to some excavation to consolidate contaminated soils. Dust control measures would be implemented to mitigate this risk. • Asphalt cap increases short-term risks during installation via emissions from paving materials
Alternative 3D - Full RCRA Cap	• An increase in short-term risk due to some excavation to consolidate contaminated soils. Dust control measures would be implemented to mitigate this risk. • Asphalt cap increases short-term risks during installation via emissions from paving materials
Alternative 4A - Limited Excavation, Off-site Disposal	• An increase in short-term risk due to some excavation to consolidate contaminated soils. Dust control measures would be implemented to mitigate this risk.

5.2.6 *Implementability*

The ease or difficulty of implementing the alternatives are compared with respect to technical and administrative feasibility, and availability of services.

All alternatives are technically implementable using standard, proven construction methods. Alternatives that include institutional controls are more difficult to implement administratively, and will require the cooperation of the local government and current property owners. The gas collection and treatment system will require an initial adjustment period, but should be easily operated soon after installation.

Table 5-6 Comparison of Implementability	
Alternative 1 - No Action	• Implementable
Alternative 2 - Fencing, Revegetation, and Institutional Controls	• Fencing and revegetation components of alternative are readily implementable • Institutional controls would require cooperation of local government and property owners in order to implement effectively
Alternative 3A - Multi-layer Soil Cap	• Implementable for cap components • Gas venting and treatment system would require initial adjustments to ensure proper operation • Institutional controls would require cooperation of local government and property owners in order to implement effectively

Table 5-6 Comparison of Implementability	
Alternative 3B - Asphalt Cap	• Implementable for cap components • Gas venting and treatment system would require initial adjustments to ensure proper operation • Institutional controls would require cooperation of local government and property owners in order to implement effectively
Alternative 3C - RCRA-Equivalent Asphalt Cap with FML, Limited Excavation	• Implementable, but would require coordination to minimize impact to surrounding community during excavation. Dust control required • Gas venting and treatment system would require initial adjustments to ensure proper operation • Institutional controls would require cooperation of local government and property owners in order to implement effectively
Alternative 3D - Full RCRA Cap	• Implementable, but would require coordination to minimize impact to surrounding community during excavation. Dust control required. • Gas venting and treatment system would require initial adjustments to ensure proper operation • Institutional controls would require cooperation of local government and property owners in order to implement effectively
Alternative 4A - Excavation, Off-site Disposal, and Institutional Controls	• Implementable, but would require coordination to minimize impact to surrounding community during excavation. Dust control required. • Institutional controls would require cooperation of local government and property owners in order to implement effectively

5.2.7 *Cost*

Cost estimates for the seven alternatives and their components are presented in the Tables 5-8 through 5-14. Table 5-7 presents a summary of the alternative cost estimates (in present worth dollars).

5.2.7.1 Monitoring Costs

Monitoring is required for any remedy that leaves waste in place. Alternative 1 provides baseline monitoring requirements that would also be conducted by any of the other alternatives. The monitoring program consists of 11 groundwater samples (7 wells, 3 upgradient and 4 downgradient plus quality assurance (QA) samples), 8 soils samples (from a variety of locations throughout the site, duplicates and QA samples) and 12 soil gas samples (taken from vapor wells within and outside the reservoir and QA samples). Soil samples would not be taken for the containment alternatives, since it would cause a breach of the cap. The costs for each sample analysis are listed in Table 3-3. The total cost of annual sampling, in present worth dollars, is listed in Table 5-8.

Monitoring costs would also include the cost of annual reports, and the required five year reviews. The annual report preparation is estimated to cost $5000.00 per year. The five year reviews are estimated to cost $10,000.00 each, and will be performed for a period of thirty years. In order to compare the alternatives, all costs are converted to present worth values, with a 5% discount rate assumed . The Present Worth of the annual reports (for 30 years) is $77,000.00. The Present Worth of the five-year reviews is $28,000.00.

Table 5-7 Comparison of Alternative Costs	
Alternative 1 - No Action	$427,500
Alternative 2 - Fencing, Revegetation, and Institutional Controls	$457,000
Alternative 3A - Multi-layer Soil Cap	$2,095,500
Alternative 3B - Asphalt Cap	$3,259,500
Alternative 3C - RCRA-Equivalent Asphalt Cap with Limited Excavation	$5,514,700
Alternative 3D - Full RCRA Cap	$12,824,700
Alternative 4A - Limited Excavation, Off-site Disposal, Institutional Controls	$12,937,700

5.2.7.2 Operation and Maintenance Costs

Annual mowing of the vacant property at WDI is required by the Weed Abatement Program of the County of Los Angeles. This cost is considered and Operation and Maintenance cost. Currently, the mowing is done by the County for $2000.00 per year. The Present Worth for this annual cost is **$31,000.00.**

5.2.7.3 Gas Venting and Treatment System

A gas venting and treatment (flaring) system is common to the containment alternatives. The estimated costs for a system is shown in Table 5-9.

Table 5-8 Annual Monitoring Costs		
Activity	**Cost**	**Present Worth**
Soil Samples (8)	$9400	$144,500
Subsurface Gas Samples (12)	$3600	$55,000
Groundwater Samples (11)	$4235	$65,000
Annual Report (30)	$5000	$77,000
Five Year Reviews (6)	$10,000	$28,000
Total without Soil Sampling		**$252,000**
Total for All Monitoring		**$396,500**

Table 5-9 Gas Collection and Treatment Costs		
Component	**Unit Cost**	**Total Cost**
HDPE Collection Piping (2500 ft)	$20.00/foot	$50,000
Condensate Collection Equipment (sump pump, storage tank, piping)		$20,000
Flaring System: - Facility construction - Blower - Flares (1)	 $10,000 $30,000 $130,000	$170,000
Condensate Disposal	$5,000/yr	$77,000
Operation and Maintenance	$7,500/yr	$115,000
Total		**$432,000**

5.2.7.4 Alternative Cost Tables

Table 5-10 Alternative 1 - No Action Costs	
Component	**Cost**
Monitoring	$396,500
Operation and Maintenance	$31,000
Total	**$427,500**

Table 5-11 Alternative 2 - Fencing, Revegetation, and Institutional Controls Costs	
Component	**Cost**
Monitoring	$396,000
Operation and Maintenance	$31,000
Capital Costs Fencing Seeding	 $25,000 $5000
Total	**$457,000**

Table 5-12 Alternative 3A - Multi-layer Soil Cap Costs	
Component	**Cost**
Monitoring (w/o soil sampling)	$252,000
Clay layer (2 feet thick, 10^{-7} cm/sec permeability) • 64,000 yd^3 @ $13/$yd^3$	$832,000
Top Soil (1 foot thick) • 32,000 yd^3 @ $14,50 yd^3	$464,000
Hydroseeding (96,000 yd^2 @ 1.25/yd^2)	$120,000
Gas Collection and Treatment System	$427,500
Total	**$2,095,500**

Table 5-13 Alternative 3B - Asphalt Cap Costs	
Component	**Cost**
Monitoring (w/o soil sampling)	$252,000
Asphalt Paving (860,000 ft^2 @ $3.00/$ft^2$)	$2,580,000
Gas Collection and Treatment System	$427,500
Total	**$3,259,500**

Table 5-14 Alternative 3C - RCRA-Equivalent Asphalt Cap Costs	
Component	**Cost**
Monitoring (w/o soil sampling)	$252,000
Excavation of contaminated soil • 78,000 yd^3 @ $10/$yd^3$	$780,000
Replacement Fill • 52,000 yd^3 @ $0.10/$yd^3$	$5,200
Flexible Membrane Liner • 750,000 ft^2 @ $2.40/$ft^2$	$1,800,000
Asphalt Paving (750,000 ft^2 @ $3.00/$ft^2$)	$2,250,000
Gas Collection and Treatment System	$427,500
Total	**$5,514,700**

Table 5-15 Alternative 3D - Full RCRA Cap Costs	
Component	**Cost**
Monitoring (w/o soil sampling)	$252,000
Excavation of contaminated soil • 78,000 yd^3 @ $10/$yd^3$	$780,000
Replacement Fill • 52,000 yd^3 @ $0.10/$yd^3$	$5,200
RCRA Cap • 750,000 ft^2 @ $15.15/$ft^2$ (from Section 3.1.5)	$11,360,000
Gas Collection and Treatment System	$427,500
Total	**$12,824,700**

Table 5-16 Alternative 4A - Excavation and Off-site Disposal Costs	
Component	**Cost**
Monitoring	$396,500
Excavation of contaminated soil • 78,000 yd^3 @ $10/$yd^3$	$780,000
Replacement Fill • 52,000 yd^3 @ $0.10/$yd^3$	$5,200
Off-site disposal of excavated soils • 52,000 yd^3 @ $225/ton (1 ton=1$yd^3$)	$11,700,000
Operation and Maintenance (mowing)	$31,000
Fencing Costs	$25,000
Total	**$12,937,700**

5.2.8 *State Acceptance*

Comments from the State of California regarding alternatives have been incorporated into the final draft of this Feasibility Study. EPA will also consider any additional comments that the State submits during the Public Comment period regarding the Proposed Plan. Initial discussions have revealed that the State does not prefer the "No Action" alternative.

5.2.9 *Community Acceptance*

The issues and concerns of the community will be addressed after the Public Comment period for the Proposed Plan is completed.

APPENDIX 1

CONTAMINATED SOIL BORINGS OUTSIDE RESERVOIR

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
1	5	Arsenic	6.0	0.97 ppm		
1	10	Arsenic	5.1	0.97 ppm		
1	**20**	**Arsenic**	**15.9**	**0.97 ppm**	*	**11.55**
1	10	Chromium	51.2	44.00 ppm		
2	5	Arsenic	5.7	0.97 ppm		
2	**10**	**Arsenic**	**11.6**	**0.97 ppm**	*	**11.55**
2	5	Beryllium	0.88	0.41 ppm		
2	10	Beryllium	0.79	0.41 ppm		
3	5	Arsenic	1.7	0.97 ppm		
3	10	Arsenic	2.2	0.97 ppm		
4	5	Arsenic	8.9	0.97 ppm		
4	10	Arsenic	1.92	0.97 ppm		
4	5	Beryllium	0.91	0.41 ppm		
4	10	Thallium	11.0	5.50 ppm		
5	40	Arsenic	4.66	0.97 ppm		
5	40	Thallium	15.4	5.50 ppm		
6	5	Arsenic	2.31	0.97 ppm		
6	10	Arsenic	3.7	0.97 ppm		
6	5	Thallium	12.0	5.50 ppm		
7	35	Arsenic	1.68	0.97 ppm		
7	35	Thallium	11.0	5.50 ppm		
8	40	Arsenic	3.22	0.97 ppm		
8	40	Thallium	9.77	5.50 ppm		
9	35	Arsenic	3.0	0.97 ppm		
9	35	Thallium	11.0	5.50 ppm		
11	15	Arsenic	3.12	0.97 ppm		
11	25	Arsenic	3.16	0.97 ppm		
11	15	Thallium	11.2	5.50 ppm		
11	25	Thallium	10.4	5.50 ppm		
13	30	Arsenic	2.24	0.97 ppm		
13	35	Arsenic	2.89	0.97 ppm		
13	35	Arsenic	2.35	0.97 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
13	30	Thallium	10.6	5.50 ppm		
13	35	Thallium	10.8	5.50 ppm		
13	35	Thallium	10.7	5.50 ppm		
15	**15**	**Arsenic**	**27.4**	**0.97 ppm**	*	**11.55**
15	**20**	**Arsenic**	**19.8**	**0.97 ppm**	*	**11.55**
15	15	Beryllium	1.3	0.41 ppm		
15	20	Beryllium	1.4	0.41 ppm		
15	15	Chromium	69.9	44.00 ppm		
15	20	Chromium	58.0	44.00 ppm		
15	**15**	**Lead**	**583.00**	**500 ppm**		**35.00**
16	**0**	**Arsenic**	**15.5**	**0.97 ppm**	*	**11.55**
16	**5**	**Arsenic**	**10.6**	**0.97 ppm**	*	**11.55**
16	10	Arsenic	6.2	0.97 ppm		
16	15	Arsenic	3.5	0.97 ppm		
16	20	Arsenic	4.69	0.97 ppm		
16	25	Arsenic	9.6	0.97 ppm		
16	35	Arsenic	3.4	0.97 ppm		
16	0	Beryllium	.92	0.41 ppm		
16	10	Beryllium	.48	0.41 ppm		
16	15	Beryllium	.91	0.41 ppm		
16	25	Beryllium	1.0	0.41 ppm		
16	35	Beryllium	.88	0.41 ppm		
16	5	Thallium	10.9	5.50 ppm		
16	20	Thallium	10.7	5.50 ppm		
17	**0**	**Arsenic**	**22.1**	**0.97 ppm**	*	**11.55**
17	10	Arsenic	7.2	0.97 ppm		
17	**15**	**Arsenic**	**17.3**	**0.97 ppm**	*	**11.55**
17	30	Arsenic	11.2	0.97 ppm	*	
17	35	Arsenic	3.8	0.97 ppm		
17	0	Beryllium	.62	0.41 ppm		
17	10	Beryllium	.93	0.41 ppm		
17	30	Beryllium	.68	0.41 ppm		

Appendix 1
Contaminated Soil Borings Outside Reservoir

SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
17	35	Beryllium	.76	0.41 ppm		
17	**15**	**Lead**	**502**	**500 ppm**		**35.00**
17	15	Thallium	12.6	5.50 ppm		
18	0	Arsenic	6.9	0.97 ppm		
18	15	Arsenic	6.22	0.97 ppm		
18	35	Arsenic	1.49	0.97 ppm		
18	0	Beryllium	.57	0.41 ppm		
18	15	Thallium	14.8	5.50 ppm		
18	35	Thallium	10.3	5.50 ppm		
19	0	Arsenic	9.5	0.97 ppm		
19	15	Arsenic	3.52	0.97 ppm		
19	35	Arsenic	2.46	0.97 ppm		
19	0	Beryllium	.8	0.41 ppm		
19	15	Thallium	9.45	5.50 ppm		
19	35	Thallium	11.0	5.50 ppm		
20	35	Arsenic	3.5	0.97 ppm		
20	35	Thallium	10.6	5.50 ppm		
21	35	Arsenic	4.98	0.97 ppm		
21	35	Thallium	11	5.50 ppm		
22	35	Arsenic	1.97	0.97ppm		
22	35	Thallium	10.8	5.50 ppm		
23	10	Arsenic	2.9	0.97 ppm		
23	15	Arsenic	5.57	0.97 ppm		
23	35	Arsenic	2.04	0.97 ppm		
23	10	Beryllium	.5	0.41 ppm		
23	5	PCBs	530 ppb	220 ppb		
23	15	Thallium	10.5	5.50 ppm		
23	35	Thallium	8.32	5.50 ppm		
24	**5**	**Arsenic**	**13.7**	**0.97 ppm**	*	**11.55**
24	10	Arsenic	2.6	0.97 ppm		
24	10	Benzo(a)pyrene	480 ppb	230 ppb		
24	10	Benzo(a)pyrene	1500	230 ppb		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
24	5	Beryllium	1.2	0.41 ppm		
24	5	Chromium	50.4	44.00 ppm		
25	5	Arsenic	5.9	0.97 ppm		
25	**5**	**Arsenic**	**54.1**	**0.97 ppm**	*	**11.55**
25	**10**	**Arsenic**	**68.7**	**0.97 ppm**	*	**11.55**
25	5	Beryllium	1.2	0.41 ppm		
25	**10**	**Chromium**	**75.7**	**44.00 ppm**		**60.50**
25	**10**	**Lead**	**1140.00**	**500 ppm**		**35.00**
27	0	Arsenic	7.6	0.97 ppm		
27	35	Arsenic	1.94	0.97 ppm		
27	0	Beryllium	.48	0.41 ppm		
27	35	Thallium	11.3	5.50 ppm		
28	35	Arsenic	1.89	0.97 ppm		
28	35	Thallium	7.72	5.50 ppm		
29	5	Arsenic	4.6	0.97 ppm		
29	15	Benzene	6700 ppb	2700 ppb		
30	30	Arsenic	2.73	0.97 ppm		
30	40	Arsenic	2.95	0.97 ppm		
30	30	Thallium	9.66	5.50 ppm		
30	40	Thallium	15.1	5.50 ppm		
31	35	Arsenic	3.75	0.97 ppm		
31	35	Thallium	8.2	5.50 ppm		
32	35	Arsenic	1.15	0.97 ppm		
32	35	Thallium	14.6	5.50 ppm		
33	**5**	**Arsenic**	**20.7**	**0.97 ppm**	*	**11.55**
33	10	Arsenic	6.97	0.97 ppm		
33	**15**	**Arsenic**	**17.4**	**0.97 ppm**	*	**11.55**
33	35	Arsenic	1.22	0.97 ppm		
33	5	Thallium	20	5.50 ppm		
33	10	Thallium	20.5	5.50 ppm		
33	15	Thallium	18	5.50 ppm		
33	35	Thallium	10.7	5.50 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
34	15	Arsenic	1.6	0.97 ppm		
36	20	Arsenic	8.2	0.97 ppm		
36	35	Arsenic	2.47	0.97 ppm		
36	20	Beryllium	.62	0.41 ppm		
36	35	Thallium	9.17	5.50 ppm		
40	5	Arsenic	6.6	0.97 ppm		
40	15	Arsenic	1.07	0.97 ppm		
40	35	Arsenic	4.45	0.97 ppm		
40	10	Benzene	3100 ppb	2700 ppb		
40	5	Beryllium	1.1	0.41 ppm		
40	15	Thallium	11.2	5.50 ppm		
40	35	Thallium	23.4	5.50 ppm		
41	0	Arsenic	7.5	0.97 ppm		
41	5	Arsenic	3.67	0.97 ppm		
41	15	Arsenic	6.16	0.97 ppm		
41	25	Arsenic	6.1	0.97 ppm		
41	35	Arsenic	1.62	0.97 ppm		
41	**40**	**Arsenic**	**12.8**	**0.97 ppm**	*	**11.55**
41	25	Benzene	6600 ppb	2700 ppb		
41	0	Beryllium	1.2	0.41 ppm		
41	20	Beryllium	.86	0.41 ppm		
41	25	Beryllium	.88	0.41 ppm		
41	40	Beryllium	.98	0.41 ppm		
41	5	Thallium	13.3	5.50 ppm		
41	15	Thallium	27.9	5.50 ppm		
41	35	Thallium	10.3	5.50 ppm		
42	5	Arsenic	3.1	0.97 ppm		
42	10	Arsenic	3.7	0.97 ppm		
42	20	Arsenic	6.1	0.97 ppm		
42	35	Arsenic	6.04	0.97 ppm		
42	5	Beryllium	.82	0.41 ppm		
42	10	Beryllium	1.0	0.41 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
42	20	Beryllium	.96	0.41 ppm		
42	35	Thallium	10.6	5.50 ppm		
43	5	Arsenic	4.2	0.97 ppm		
43	35	Arsenic	1.85	0.97 ppm		
43	5	Beryllium	.63	0.41 ppm		
43	35	Thallium	8.75	5.50 ppm		
44	10	Arsenic	3.8	0.97 ppm		
44	35	Arsenic	1.92	0.97 ppm		
44	10	Beryllium	.69	0.41 ppm		
44	**35**	**Cadmium**	**50.1**	**39.00 ppm**		**1.82**
44	35	Thallium	9.49	5.50 ppm		
45	5	Arsenic	1.3	0.97 ppm		
45	20	Arsenic	6.6	0.97 ppm		
45	20	Arsenic	4.0	0.97 ppm		
45	**35**	**Arsenic**	**12.2**	**0.97 ppm**	*	**11.55**
45	45	Arsenic	1.3	0.97 ppm		
45	5	Beryllium	1.1	0.41 ppm		
46	0	Arsenic	5.4	0.97 ppm		
46	0	Arsenic	9.1	0.97 ppm		
46	10	Arsenic	6.1	0.97 ppm		
46	15	Arsenic	5.9	0.97 ppm		
46	15	Arsenic	1.5	0.97 ppm		
46	20	Arsenic	7.4	0.97 ppm		
46	20	Arsenic	7.1	0.97 ppm		
46	30	Arsenic	2.8	0.97 ppm		
46	30	Arsenic	4.2	0.97 ppm		
46	40	Arsenic	1.4	0.97 ppm		
46	50	Arsenic	1.0	0.97 ppm		
50	0	Arsenic	10.9	0.97 ppm	*	
50	0	Beryllium	.61	0.41 ppm		
51	30	Arsenic	2.29	0.97 ppm		
51	35	Arsenic	7.04	0.97 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
51	30	Thallium	12.4	5.50 ppm		
51	35	Thallium	12.1	5.50 ppm		
52	35	Arsenic	7.5	0.97 ppm		
52	35	Thallium	11.7	5.50 ppm		
53	5	Arsenic	5.28	0.97 ppm		
53	20	Arsenic	8.88	0.97 ppm		
53	35	Arsenic	2.81	0.97 ppm		
53	5	Thallium	20.1	5.50 ppm		
53	20	Thallium	27.7	5.50 ppm		
53	35	Thallium	12.5	5.50 ppm		
54	5	Arsenic	4.98	0.97 ppm		
54	10	Arsenic	5.1	0.97 ppm		
54	20	Arsenic	7.5	0.97 ppm		
54	35	Arsenic	2.22	0.97 ppm		
54	10	Beryllium	1.10	0.41 ppm		
54	20	Beryllium	1.2	0.41 ppm		
54	5	Thallium	14.8	5.50 ppm		
54	35	Thallium	14.8	5.50 ppm		
55	0	Arsenic	4.1	0.97 ppm		
55	0	Arsenic	8.6	0.97 ppm		
55	5	Arsenic	9.4	0.97 ppm		
55	**10**	**Arsenic**	**12.8**	**0.97 ppm**	*	**11.55**
55	25	Arsenic	2.96	0.97 ppm		
55	35	Arsenic	2.05	0.97 ppm		
55	0	Beryllium	1.2	0.41 ppm		
55	0	Beryllium	.82	0.41 ppm		
55	5	Beryllium	.59	0.41 ppm		
55	25	Beryllium	.58	0.41 ppm		
55	**10**	**Lead**	**543.00**	**500 ppm**		**35.00**
55	10	PCBs	19000 ppb	220 ppb	*	
55	10	PCBs	23000 ppb	220 ppb	*	
55	10	Thallium	19.8	5.50 ppm		

Appendix 1
Contaminated Soil Borings Outside Reservoir

SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
55	25	Thallium	27.6	5.50 ppm		
55	35	Thallium	13.1	5.50 ppm		
56	0	Arsenic	5.5	0.97 ppm		
56	10	Arsenic	5.8	0.97 ppm		
56	25	Arsenic	9.37	0.97 ppm		
56	35	Arsenic	6.58	0.97 ppm		
56	0	Beryllium	.46	0.41 ppm		
56	10	Beryllium	.72	0.41 ppm		
56	25	Thallium	22.2	5.50 ppm		
56	35	Thallium	14.6	5.50 ppm		
60	0	Arsenic	6	0.97 ppm		
60	10	Arsenic	3.9	0.97 ppm		
60	10	Arsenic	3.4	0.97 ppm		
60	20	Arsenic	2.9	0.97 ppm		
60	**20**	**Arsenic**	**11.8**	**0.97 ppm**	*	**11.55**
60	**35**	**Arsenic**	**19.0**	**0.97 ppm**	*	**11.55**
60	0	Beryllium	.93	0.41 ppm		
60	10	Beryllium	.5	0.41 ppm		
60	10	Beryllium	.97	0.41 ppm		
60	10	Beryllium	.78	0.41 ppm		
60	20	Beryllium	.64	0.41 ppm		
60	20	Beryllium	1.0	0.41 ppm		
60	35	Thallium	10.4	5.50 ppm		
61	35	Arsenic	9.55	0.97 ppm		
61	35	Thallium	16.3	5.50 ppm		
62	**0**	**Arsenic**	**12.4**	**0.97 ppm**	*	**11.55**
62	**10**	**Arsenic**	**13.9**	**0.97 ppm**	*	**11.55**
62	10	Arsenic	7.72	0.97 ppm		
62	**20**	**Arsenic**	**17.0**	**0.97 ppm**	*	**11.55**
63	35	Arsenic	1.08	0.97 ppm		
63	35	Thallium	11.2	5.50 ppm		
64	0	Benzo(a)pyrene	750 ppb	0.23 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
65	15	Arsenic	4.26	0.97 ppm		
65	30	Arsenic	3.56	0.97 ppm		
65	35	Arsenic	2.26	0.97 ppm		
65	40	Arsenic	3.95	0.97 ppm		
65	45	Arsenic	1.45	0.97 ppm		
65	15	Thallium	15.4	5.50 ppm		
65	30	Thallium	14.9	5.50 ppm		
65	35	Thallium	13.4	5.50 ppm		
65	40	Thallium	16.0	5.50 ppm		
65	45	Thallium	13.4	5.50 ppm		
66	5	Arsenic	4.61	0.97 ppm		
66	20	Arsenic	3.21	0.97 ppm		
66	20	Arsenic	7.36	0.97 ppm		
66	25	Arsenic	1.5	0.97 ppm		
66	30	Arsenic	1.11	0.97 ppm		
66	35	Arsenic	5.9	0.97 ppm		
66	40	Arsenic	7.18	0.97 ppm		
66	45	Arsenic	3.5	0.97 ppm		
66	20	Beryllium	.79	0.41 ppm		
66	35	Beryllium	1.0	0.41 ppm		
66	**20**	**Lead**	**836.00**	**500 ppm**		**35.00**
66	5	Thallium	16.7	5.50 ppm		
66	20	Thallium	22.4	5.50 ppm		
66	20	Thallium	15.4	5.50 ppm		
66	30	Thallium	10.8	5.50 ppm		
66	40	Thallium	15.8	5.50 ppm		
67	0	Arsenic	9.5	0.97 ppm		
67	**20**	**Arsenic**	**12.5**	**0.97 ppm**	*	**11.55**
67	25	Arsenic	10.2	0.97 ppm	*	
67	30	Arsenic	2.91	0.97 ppm		
67	**35**	**Arsenic**	**12.8**	**0.97 ppm**	*	**11.55**
67	40	Arsenic	7.4	0.97 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
67	**40**	**Arsenic**	**18.5**	**0.97 ppm**	*	**11.55**
67	45	Arsenic	2.9	0.97 ppm		
67	0	Beryllium	1.0	0.41 ppm		
67	**20**	**Beryllium**	**1.4**	**0.41 ppm**		**1.39**
67	25	Beryllium	.84	0.41 ppm		
67	40	Beryllium	1.3	0.41 ppm		
67	30	Thallium	14.9	5.50 ppm		
67	35	Thallium	15.9	5.50 ppm		
68	**0**	**Arsenic**	**16.5**	**0.97 ppm**	*	**11.55**
68	20	Arsenic	11.3	0.97 ppm	*	
68	25	Arsenic	6.33	0.97 ppm		
68	0	Benzo(a)pyrene	290 ppb	230 ppb		
68	0	Beryllium	.59	0.41 ppm		
68	20	Beryllium	1.3	0.41 ppm		
68	**0**	**Lead**	**731.00**	**500 ppm**		**35.00**
68	25	Thallium	11.2	5.50 ppm		
69	**0**	**Arsenic**	**12.9**	**0.97 ppm**	*	**11.55**
69	**5**	**Arsenic**	**12.2**	**0.97 ppm**	*	**11.55**
69	10	Arsenic	9.62	0.97 ppm		
69	15	Arsenic	5.1	0.97 ppm		
69	**20**	**Arsenic**	**13.7**	**0.97 ppm**	*	**11.55**
69	35	Arsenic	4.22	0.97 ppm		
69	0	Beryllium	.68	0.41 ppm		
69	**15**	**Beryllium**	**1.4**	**0.41 ppm**		**1.39**
69	20	Beryllium	.95	0.41 ppm		
69	20	N-Nitroso-di-n-propylamine	2700 ppb	240 ppb	*	
69	5	Thallium	10.1	5.50 ppm		
69	10	Thallium	11.7	5.50 ppm		
69	35	Thallium	8.11	5.50 ppm		
70	30	Arsenic	5.3	0.97 ppm		
71	10	Arsenic	6.4	0.97 ppm		

Appendix 1
Contaminated Soil Borings Outside Reservoir

SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
71	20	Arsenic	3.5	0.97 ppm		
72	35	Arsenic	3.13	0.97 ppm		
72	35	Thallium	9.52	5.50 ppm		
73	5	Arsenic	11	0.97 ppm	*	
73	5	Benzo(a)pyrene	480 ppb	0.23 ppm		
73	5	Thallium	27.7	5.50 ppm		
75	0	Arsenic	5.31	0.97 ppm		
75	5	Arsenic	5.66	0.97 ppm		
75	35	Arsenic	7.02	0.97 ppm		
75	0	Thallium	16.7	5.50 ppm		
75	5	Thallium	20.0	5.50 ppm		
75	35	Thallium	32.6	5.50 ppm		
76	10	Arsenic	2.8	0.97 ppm		
76	10	Arsenic	2.7	0.97 ppm		
76	20	Arsenic	7.6	0.97 ppm		
76	20	Arsenic	5.8	0.97 ppm		
76	30	Arsenic	2.1	0.97 ppm		
76	30	Arsenic	9.1	0.97 ppm		
76	40	Arsenic	1.0	0.97 ppm		
76	40	Arsenic	2.7	0.97 ppm		
77	5	Arsenic	4.87	0.97 ppm		
77	10	Arsenic	3.3	0.97 ppm		
77	10	Beryllium	.74	0.41 ppm		
77	5	Thallium	22.8	5.50 ppm		
78	**10**	**Arsenic**	**12.1**	**0.97 ppm**	*	**11.55**
79	35	Arsenic	5.5	0.97 ppm		
79	0	PCBs	1700 ppb	220 ppb		
79	35	Thallium	11.2	5.50 ppm		
81	**35**	**Arsenic**	**18**	**0.97 ppm**	*	**11.55**
81	35	Thallium	12.5	5.50 ppm		
82	10	Arsenic	2.9	0.97 ppm		
82	20	Arsenic	4.9	0.97 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
82	25	Arsenic	5.0	0.97 ppm		
82	10	Beryllium	1.0	0.41 ppm		
83	5	Arsenic	6.1	0.97 ppm		
83	10	Arsenic	5.4	0.97 ppm		
83	10	Arsenic	7.1	0.97 ppm		
83	15	Arsenic	6.53	0.97 ppm		
83	20	Arsenic	5.8	0.97 ppm		
83	**35**	**Arsenic**	**12.2**	**0.97 ppm**	*	**11.55**
83	40	Arsenic	3.53	0.97 ppm		
83	**40**	**Arsenic**	**15.1**	**0.97 ppm**	*	**11.55**
83	45	Arsenic	1.9	0.97 ppm		
83	5	Beryllium	1.0	0.41 ppm		
83	10	Beryllium	1.1	0.41 ppm		
83	10	Beryllium	1.0	0.41 ppm		
83	20	Beryllium	1.1	0.41 ppm		
83	40	Beryllium	1.1	0.41 ppm		
83	**40**	**Lead**	**2640**	**500 ppm**		**35.00**
83	15	Thallium	13.7	5.5 ppm		
83	35	Thallium	15.7	5.5 ppm		
83	40	Thallium	16.2	5.5 ppm		
83	45	Thallium	14.9	5.5 ppm		
84	5	Arsenic	4.2	0.97 ppm		
84	20	Arsenic	2.4	0.97 ppm		
84	35	Arsenic	8.37	0.97 ppm		
84	5	Beryllium	1.2	0.41 ppm		
84	20	Beryllium	1.1	0.41 ppm		
84	10	DDD	62	7.10 ppm		
84	10	DDE	30 ppm	5.00 ppm		
84	10	DDT	260 ppm	5.00 ppm	*	
84	35	Thallium	15.2	5.50 ppm		
85	5	Arsenic	9.3	0.97 ppm		
85	10	Arsenic	5.7	0.97 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
85	15	Arsenic	7.3	0.97 ppm		
85	25	Arsenic	2.6	0.97 ppm		
85	35	Arsenic	6.6	0.97 ppm		
85	5	Beryllium	1.1	0.41 ppm		
85	10	Beryllium	1.2	0.41 ppm		
85	15	Beryllium	1.2	0.41 ppm		
85	35	Beryllium	1.1	0.41 ppm		
86	5	Arsenic	4.5	0.97 ppm		
86	10	Arsenic	7.4	0.97 ppm		
86	15	Arsenic	10.7	0.97 ppm	*	
86	**20**	**Arsenic**	**11.9**	**0.97 ppm**	*	**11.55**
87	0	Arsenic	5.5	0.97 ppm		
87	0	Arsenic	4.8	0.97 ppm		
87	10	Arsenic	4.4	0.97 ppm		
87	10	Arsenic	3.8	0.97 ppm		
87	20	Arsenic	2.2	0.97 ppm		
87	10	Beryllium	.97	0.41 ppm		
87	**0**	**Lead**	**660**	**500 ppm**		**35.00**
88	5	Arsenic	2.8	0.97 ppm		
88	10	Arsenic	8.6	0.97 ppm		
88	**15**	**Arsenic**	**18.**	**0.97 ppm**	*	**11.55**
88	20	Arsenic	3.9	0.97 ppm		
88	25	Arsenic	2.4	0.97 ppm		
88	30	Arsenic	10.5	0.97 ppm	*	
88	35	Arsenic	2.8	0.97 ppm		
88	40	Arsenic	2.6	0.97 ppm		
88	45	Arsenic	2.0	0.97 ppm		
88	10	Beryllium	1.1	0.41 ppm		
88	15	Beryllium	.75	0.41 ppm		
88	30	Beryllium	1.3	0.41 ppm		
89	5	Arsenic	5.1	0.97 ppm		
89	**10**	**Arsenic**	**13.3**	**0.97 ppm**	*	**11.55**

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
89	20	Arsenic	3.7	0.97 ppm		
89	25	Arsenic	7.2	0.97 ppm		
*89	35	Arsenic	3.5	0.97 ppm		
89	35	Arsenic	7.4	0.97 ppm		
89	5	Beryllium	.97	0.41 ppm		
89	10	Beryllium	1.1	0.41 ppm		
89	25	Beryllium	1.2	0.41 ppm		
89	35	Beryllium	1.0	0.41 ppm		
89	10	Chromium	49.20	44 ppm		
90	5	Arsenic	4.4	0.97 ppm		
90	5	Benzo(a)pyrene	960 ppb	230 ppb		
90	5	Chromium	55.8	44 ppm		
90	5	Thallium	13.1	5.5 ppm		
91	0	Arsenic	3.0	0.97 ppm		
91	0	Beryllium	0.84	0.41 ppm		
92	0	Arsenic	2.4	0.97 ppm		
92	10	Arsenic	5.6	0.97 ppm		
92	**20**	**Arsenic**	**19.6**	**0.97 ppm**	*	**11.55**
92	**35**	**Arsenic**	**17.8**	**0.97 ppm**	*	**11.55**
92	**35**	**Arsenic**	**17**	**0.97 ppm**	*	**11.55**
92	0	Beryllium	0.57	0.41 ppm		
92	10	Beryllium	.96	0.41 ppm		
92	20	Beryllium	.9	0.41 ppm		
92	35	Thallium	13	5.50 ppm		
92	35	Thallium	10.5	5.50 ppm		
93	35	Arsenic	4.94	0.97 ppm		
93	35	Thallium	8.63	5.50 ppm		
96	**0**	**Arsenic**	**36.4**	**0.97 ppm**	*	**11.55**
96	10	Arsenic	5.5	0.97 ppm		
96	30	Arsenic	5.2	0.97 ppm		
96	40	Arsenic	3.93	0.97 ppm		
96	55	Arsenic	1.9	0.97 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
96	0	Beryllium	.54	0.41 ppm		
96	10	Beryllium	.95	0.41 ppm		
96	30	Beryllium	.72	0.41 ppm		
96	40	Thallium	8.12	5.50 ppm		
97	0	Arsenic	3.4	0.97 ppm		
97	0	Arsenic	4.1	0.97 ppm		
97	10	Arsenic	8.1	0.97 ppm		
97	10	Arsenic	6.5	0.97 ppm		
97	20	Arsenic	2.0	0.97 ppm		
97	20	Arsenic	3.4	0.97 ppm		
97	40	Arsenic	2.71	0.97 ppm		
97	0	Beryllium	.46	0.41 ppm		
97	10	Beryllium	1.3	0.41 ppm		
97	10	Beryllium	1.0	0.41 ppm		
97	20	Beryllium	.82	0.41 ppm		
97	40	Thallium	10.7	5.50 ppm		
98	10	Arsenic	3.7	0.97 ppm		
98	**20**	**Arsenic**	**18.6**	**0.97 ppm**	*	**11.55**
98	20	Arsenic	2.8	0.97 ppm		
98	30	Arsenic	5.3	0.97 ppm		
98	40	Arsenic	2.9	0.97 ppm		
98	10	Beryllium	.72	0.41 ppm		
98	20	Beryllium	.77	0.41 ppm		
98	20	Beryllium	.79	0.41 ppm		
103	0	Arsenic	6.3	0.97 ppm		
103	5	Arsenic	7.4	0.97 ppm		
103	10	Arsenic	7.57	0.97 ppm		
103	15	Arsenic	4.79	0.97 ppm		
103	35	Arsenic	6.19	0.97 ppm		
103	40	Arsenic	1.94	0.97 ppm		
103	5	Beryllium	1.4	0.41 ppm		
103	10	Beryllium	.53	0.41 ppm		

Appendix 1 Contaminated Soil Borings Outside Reservoir						
SB	FT	Contaminant	Concentration	PRG	Exceeds 10E-5	5 X BGL
103	0	PCBs	3.2	0.22 ppm	*	
103	0	Thallium	15.0	5.50 ppm		
103	10	Thallium	15.4	5.50 ppm		
103	15	Thallium	12.6	5.50 ppm		
103	35	Thallium	21.3	5.50 ppm		
103	40	Thallium	14.8	5.50 ppm		
104	0	Arsenic	7.3	0.97 ppm		
104	10	Arsenic	3.3	0.97 ppm		
104	20	Arsenic	6.7	0.97 ppm		
104	**35**	**Arsenic**	**18.0**	**0.97 ppm**	*	**11.55**
104	0	Beryllium	1.2	0.41 ppm		
104	10	Beryllium	.97	0.41 ppm		
104	20	Beryllium	.72	0.41 ppm		
104	35	Beryllium	1.0	0.41 ppm		
104	**35**	**Chromium**	**62.7**	**44.00 ppm**		**60.50**

* - CONTAMINANT CONCENTRATION EXCEEDS RISK VALUE OF 10E-5
BOLD - CONTAMINANT CONCENTRATION EXCEEDS FIVE TIMES THE BACKGROUND LEVEL CONCENTRATION